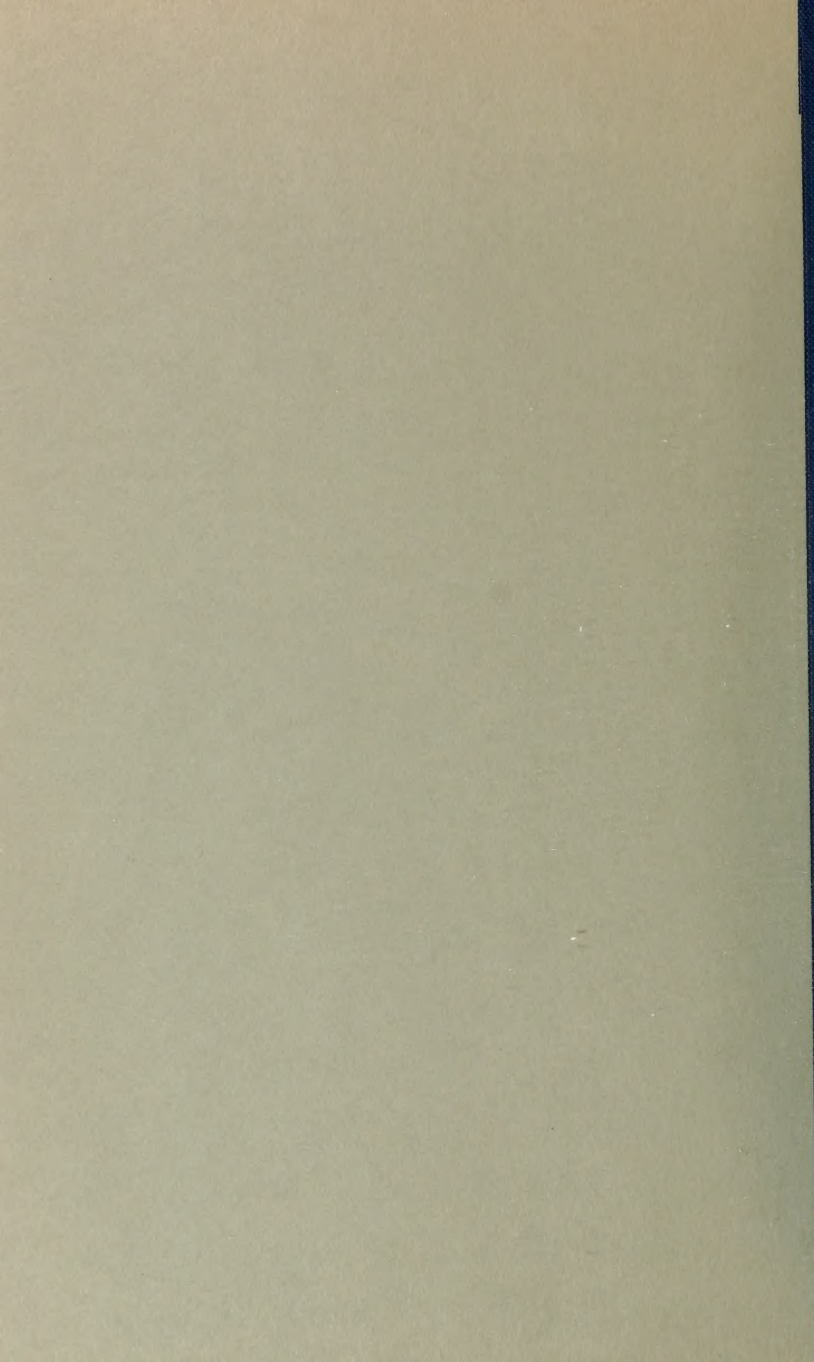


Biological
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Serials

Canada. Dept. of Agriculture. Entomology Research Institute
Report of the Dominion Entomologist

1915-16



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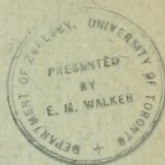
CANADA
DEPARTMENT OF AGRICULTURE


REPORT
OF THE
DOMINION ENTOMOLOGIST

C. GORDON HEWITT, D.Sc., F.R.S.C.

FOR THE
YEAR ENDING MARCH 31, 1916

OTTAWA
Printed by J. DE L. TACHÉ,
Printer to the King's Most Excellent Majesty.
1917





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Report of the Dominion Entomologist

C. GORDON HEWITT, D.Sc., F.R.S.C.

FOR THE YEAR ENDING MARCH 31, 1916.

OTTAWA, March 31, 1916.

To the Honourable
The Minister of Agriculture,
Ottawa.

SIR,—I have the honour to submit herewith my report on the work of the Entomological Branch for the year ending March 31, 1916.

In addition to a brief account of the progress of the investigations which have been undertaken or continued by the officers of my Branch both at headquarters and in the field, reference is also made, for the purpose of permanent record and for the use of other workers, to the depredations of certain insects which were unusually abundant and injurious during the season of 1915 which this report covers.

The work of the Branch has comprised the following:—

1. The Administration of the Destructive Insect and Pest Act (Insects and Pests Section) including:
 - (a) Inspection and fumigation of imported nursery stock and other plant products.
 - (b) Field work against the brown-tail moth.
2. Introduction and colonization of parasitic insects and the study of natural control.
Investigations on the following:
 3. Insects affecting cereal and field crops, garden and greenhouse.
 4. Insects affecting fruit crops.
 5. Insects affecting forest and shade trees.
 6. Insects affecting grain and other stored products.
 7. Insects affecting domestic and other animals, household and public health.
8. The maintenance of the National Collection of Insects.
9. Miscellaneous.

As the Field Laboratories are now established on a permanent basis the present report differs from my previous reports in as much as the work of the various laboratories is reported upon separately with a view to indicating more clearly the nature of the investigations that are being conducted at each of these laboratories. The first part of this report will therefore give a summarized account of the different lines of work undertaken by my Branch and the more detailed accounts will be found in the reports of the officers at Ottawa and those in charge of Field Laboratories.

FIELD LABORATORIES.

The successful character of the work that we have been able to undertake through the medium of the Field Laboratories and the demand on the part of agriculturists and others for further assistance in controlling insect pests and outbreaks rendered it necessary to place a further number of these laboratories on a permanent basis by erecting permanent buildings to take the place of the small temporary buildings which hitherto had served as headquarters for the work. Entomological laboratories providing adequate accommodation for the field officers and other assistants and the work that they are carrying on were erected during the past year at the following places:

Annapolis Royal, N.S.
Treesbank, Man.

Fredericton, N.B.
Lethbridge, Alta.

Annapolis Royal, N.S.—The laboratory is erected on an excellent site on the county school grounds which the school board of Annapolis Royal has kindly provided. The building measures twenty-six feet square and consists of basement, ground floor and attic. In the roomy basement accommodation is provided for field and spraying equipment; it also contains a dark-room and lavatory. The ground floor is divided into three rooms, namely: an office for the field officer in charge, a large laboratory and a general work room. The commodious attic is specially well lighted to serve as photographic room and work room. Steam-heating is installed.

Fredericton, N.B.—The laboratory is of solid brick construction and measures twenty-four feet by thirty feet. It consists of basement, ground floor, first floor and attic. The basement contains the water supply for the building, comprising a well, tank, and electrically driven pump, and provides storage room for field equipment and supplies. The ground floor contains, at the front, offices for the two officers in charge of the work: Mr. J. D. Tothill who has charge of the colonisation and study of the parasitic insects and Mr. L. S. McLaine who has charge of the field work against the Brown-tail Moth in New Brunswick and the collection of parasites in the New England States; at the back of the ground floor is a work room. On the first floor a large laboratory occupies the front half of the building and a specially lighted room is provided behind for photographic and other work; a dark-room and bath-room are also provided on this floor. The high pitched roof furnishes a roomy attic for storage purposes. Steam-heating and electric light have been installed. The building is well situated on the University campus on a site which the University authorities have generously provided.

Treesbank, Man.—A small wooden laboratory measuring twelve feet by sixteen feet has been erected during the past summer on a site kindly provided by Mr. Percy Criddle on his farm, where excellent facilities occur for field and experimental work.

Lethbridge, Alta.—The laboratory measures twenty-three feet by twenty feet and contains four rooms, namely: office, laboratory, spare room and dark-room. By arrangement the Director of the Experimental Farms and the Superintendent of the Station have kindly furnished for experimental purposes a small plot of ground adjoining the laboratory.

ADMINISTRATION OF THE DESTRUCTIVE INSECT AND PEST ACT.

INSPECTION AND FUMIGATION OF IMPORTED NURSERY STOCK.

Nursery stock, trees and plants originating in countries in which the San José scale occurs, were fumigated at various fumigation stations. During the year an arrangement was concluded with the Government of the province of Nova Scotia whereby they undertook to fumigate under our supervision foreign nursery stock destined to points in Nova Scotia. This arrangement is similar to the one we have had for several years with the province of British Columbia and was rendered possible by the enactment of legislation on the part of the provincial government and the organisation of an inspection service for the fumigation and inspection of nursery stock entering the province. To permit this arrangement Truro, N.S., and Digby, N.S., were declared ports of entry for foreign nursery stock by Order-in-Council on August 18, 1915.

During the statutory importation season of 1914-15 we inspected 2,336,558 imported trees and plants originating in Europe, Japan and the New England States for gipsy and brown-tail moths and other foreign insect pests to which they are subject. Owing to the disturbed conditions in Europe, particularly in Belgium and France, from which countries Canadian nurserymen and florists are accustomed to import the larger portion of their nursery stock, the number of plants imported during the season 1914-15 was about half of the number imported during the previous season when nearly five million trees were inspected.

Each year we are improving the inspection service, particularly by undertaking, so far as is possible, the inspection of imports at the ports of entry in eastern Canada instead of permitting them to proceed to destination for inspection there. This arrangement is possible in the case of small shipments and results in greater convenience to small importers and the saving of the time of our inspectors. It will always be necessary to allow large shipments of machine-packed nursery stock to proceed to destination for the convenience of the importers and ourselves.

FIELD WORK AGAINST THE BROWN-TAIL MOTH.

The brown-tail moth situation in Nova Scotia and New Brunswick is in a satisfactory condition. In spite of an increase of the infested area in these provinces, owing to the immigration and spread of the moths

from the New England States, the intensity of the infestation has been decreased in both provinces by the careful work of the officers in charge of the work: Mr. G. E. Sanders in Nova Scotia and Mr. L. S. McLaine in New Brunswick.

During the winter season 1914-15, 18,154 winter webs were collected in Nova Scotia; and in New Brunswick only 239 webs were collected in the infested territory in which 28,119 webs were collected in the previous season. This decrease in New Brunswick, in which province we have been able so far to prevent the establishment of the brown-tail moth, was due to the careful scouting work during the previous winter (1913-14) and to the following natural causes: the unfavourable conditions at the time of the flight of the moths from the New England States and the heavy mortality of the caterpillars in the preceding winter owing to climatic conditions.

The governments of the provinces of Nova Scotia and New Brunswick have continued their co-operation in the scouting work and I am pleased to acknowledge the assistance of the inspectors whom they have placed at our disposal.

We are also indebted to the Federal Horticultural Board of the United States Department of Agriculture for their co-operation, particularly in the matter of inspecting trains leaving the brown-tail and gipsy moth quarantined area in the New England States and destined for Canadian points during the flight period of the moths.

As yet the gipsy moth has not reached Canada from the United States, although in its northeasterly spread in the state of Maine it has now reached within fifty miles of the international boundary and its discovery in New Brunswick at any time would not surprise us in view of the extent to which the small larvae may be spread by the wind. The United States Department of Agriculture annually carries out a careful scout of the territory adjoining the known limits of the area infested by the gipsy moth.

INTRODUCTION OF PARASITIC INSECTS AND THE STUDY OF NATURAL CONTROL.

Through the co-operation of the Bureau of Entomology of the United States Department of Agriculture we have been able to continue the work of collecting certain of the parasites of the brown-tail and gipsy moths and the predatory beetle *Calosoma* in the New England States, particularly in Massachusetts, for the purpose of shipment to Canada and colonization in the provinces infested with the brown-tail moth and likely to be invaded by the gipsy moth.

Dr. L. O. Howard, Chief of the United States Bureau of Entomology again kindly provided accommodation for my officer Mr. L. S. McLaine and his three assistants at the Gipsy Moth Laboratory, Melrose Highlands, Mass., where the parasitic material was assembled and the parasites were reared, packed and shipped to our laboratory at Fredericton, N.B., at which point Mr. J. D. Tothill took charge of the distribution of the colonies at strategical points in the provinces of Nova Scotia, New Brunswick and Quebec. This was the fourth season's work and up to date over 72,000

parasites (*Compsilura concinnata*, *Apanteles lacteicolor* and *Meteorus versicolor*) and 3,400 predaceous beetles (*Calosoma sycophanta*) have been collected or reared and imported and liberated.

The study of the natural control of native insects has been continued by Mr. J. D. Tothill at the Entomological Laboratory at Fredericton, N.B. The natural control of the three native insect pests: the forest tent caterpillar, *Malacosoma disstria*, the fall webworm, *Hyphantria textor*, and the spruce bud-worm, *Harmoloba fumiferana*, was investigated further along the lines indicated in my last report, with interesting results.

INSECTS AFFECTING CEREAL, FIELD CROPS, GARDEN AND GREENHOUSE.

Mr. Arthur Gibson, my Chief Assistant, has had charge of the work relating to insects affecting field crops, garden and greenhouse and his report follows. During the year cutworms were unusually abundant throughout Canada. They were particularly prevalent in the prairie provinces where they attacked grain and garden crops. The chief species in the west proved to be the red-backed cutworm, *Eucrotia ochrogaster* Gn., which destroyed considerable areas of wheat and oats. The infested areas were visited by our field officer for Manitoba, Mr. Norman Criddle and advice, based on our experimental work, was given.

In southern Alberta an extensive outbreak of the army cutworm, *Chorizagrotis auxiliaris*, occurred. This is the first time that this species has attained destructive proportions in Canada, and as the outbreak covered an area of about 3,000 square miles, it caused no little apprehension among the grain growers. Our resident field officer, Mr. E. H. Strickland immediately investigated the outbreak and discovered means of controlling the spread of the insects, with the result that, by means of field demonstrations of the control measures and by press notices widespread damage and loss was prevented.

Satisfactory progress has been made in the investigation that we are conducting in Ontario and Manitoba on white grubs (*Lachnosterna* spp.) and important data affecting their control have already been secured as a result of this thorough study.

In Manitoba we have commenced a study of the distribution and life-histories of the grass stem-maggot flies (Oscinidae) which affect grasses and cereals. In the identification of the species collected, Dr. J. M. Abdrich of the United States Bureau of Entomology has rendered most welcome and valuable help.

The investigations on the root maggots, particularly the cabbage root maggot, *Phorbia brassicae*, that we have been carrying on for a number of years, have reached a stage at which I think we are justified in publishing our results as these insects are annually becoming more serious as a pest of field and garden crops throughout the dominion. Accordingly, a bulletin has been prepared by Messrs. Gibson and Treherne embodying the results of their work in Ontario and British Columbia respectively and this is now in the press.

Locusts, particularly the lesser migratory locust, *Melanoplus atlantis* Riley, were very abundant during 1915 in eastern Canada, especially in the provinces of Quebec and Ontario. The timely publication of Entomological Circular No. 5, giving the results of our successful experiments on the control of these insects, was the means of preventing serious losses to crops where the remedies were applied. In a number of localities the farmers co-operated in purchasing insecticides and carrying out control measures, and the poisoned bait we recommended was thus distributed over large areas of infested land the results being very encouraging by their success. The most striking example of such co-operation was in the county of St. Maurice in Quebec, where the continued destruction of crops and grass land had resulted in the abandonment of many farms and general discouragement among the farmers. Following conferences with us the parish priests organized the farmers in certain parishes and altogether 33,347 acres were treated; in the single parish of St. Etienne de Grès alone 21,000 acres were treated.

Greater attention is now being devoted to a study of insects affecting greenhouse and florists' stock. We find that there is an increasing demand for information on the control of this class of insects which offers an important field for investigation.

INSECTS AFFECTING FRUIT CROPS.

At four of the field laboratories the officers in charge have devoted most of their time to the study and control of insects affecting orchard, bush and small fruits.

In Nova Scotia special attention has been paid to the investigation of insecticides and orchard spraying with gratifying results. Experimental and demonstration work was carried out in different orchards through the Annapolis Valley and largely through this work and the energetic spraying campaign carried out by our officer, Mr. Sanders, the number of orchardists who spray has been increased and spraying methods have been perfected with a consequent improvement in the quantity and quality of the fruit. The testimony and gratitude of the fruit-growers has been a most encouraging feature of our work.

The work in Quebec has been largely in the nature of demonstrating the methods of controlling orchard insects, particularly the apple curculio, *Anthonomus quadrigibbus*, based on the work of previous seasons. In certain sections in which spraying has not hitherto been practised the results of these demonstrations were of a convincing nature. In this work the Department of Agriculture of Quebec co-operated by furnishing power sprayers and insecticides.

In Ontario we have continued our investigations on the different species of *Aphis* affecting apple, particularly *A. sorbi*, *A. pomi* and *A. avenae*, and on the control of the apple maggot, *Rhagoletis pomonella*. In addition observations were made on the following fruit pests: the pear psylla, *Psylla pyricolor*, cherry aphid, *Myzus cerasi*, and raspberry byturus, *Byturus unicolor*.

The outstanding features of the fruit insect situation in British Columbia were the discovery of a serious outbreak of the pear thrips

Taeniothrips pyri, near Victoria, B.C., and the occurrence of the currant bud mite, *Eriophyes ribis*. Arrangements have been made for a thorough investigation of the pear thrips outbreak and its life-history and control under British Columbia conditions; a special officer Dr. A. E. Cameron will be detailed for that purpose. The Provincial Department of Agriculture will co-operate with us in conducting eradication measures which will be carried out under the direction of our field officer Mr. R. C. Treherne. The Provincial Department also proposes to undertake immediate steps to eradicate, so far as is possible, the outbreak of the currant bud mite. The codling moth would appear to be definitely established now in certain restricted localities in the province and we propose to study its behaviour and control under local conditions; plans for this investigation have already been made.

INSECTS AFFECTING FOREST AND SHADE TREES.

The work of the year followed the same lines as that of previous years. Chief attention was directed to control measures for the various insects affecting the trees in Stanley Park, Vancouver, B.C., and to the investigation of a destructive wood-borer in cedar which was reported to us. Mr. Swaine, Assistant Entomologist in charge of forest insect investigations, visited the Lesser Slave lake region in northern Alberta for the purpose of investigating forest insect injuries, and useful information was secured. He also examined the forest insect conditions in the National Parks at Glacier, B.C., Field, B.C., and Banff, Alta., with a view to furnishing advice on the protection of the valuable forests in these Parks.

At our forest insect laboratory in Stanley Park, Vancouver, B.C., further studies on the Sitka spruce gall aphid, *Chermes coalcei* Gillette, and a variety affecting Douglas fir were made.

In New Brunswick the spruce bud-worm, *Harmolopa fuscifera*, continued its depredations and caused unnecessary alarm in some regions. Our study of its control by natural factors was continued. The larch saw-fly, *Nematus erichsonii*, is spreading westward and further reports were received from Saskatchewan. On the prairie provinces a number of insects were reported defoliating ornamental and other trees; canker worms were unusually abundant and widespread injuries were caused by the negundo plant louse, *Chaitophorus negundinis*, and the poplar leaf beetle, *Galerucella decora*. More attention is now being paid by us to the shade tree pests in eastern Canada.

INSECTS AFFECTING GRAIN AND OTHER STORED PRODUCTS.

In view of the increase in storage facilities for grain throughout Canada an investigation has been started with a view to determining the extent to which grain and other stored products such as dried fruits, tobacco, etc., are affected by insect pests and the best methods of controlling them. The chief elevators and flour mills in eastern and western Canada are being visited and the assistance of the companies owning them is being sought. We find that the present methods of controlling insects affecting flour mills entail a considerable annual expense.

INSECTS AFFECTING DOMESTIC AND OTHER ANIMALS,
HOUSEHOLD AND PUBLIC HEALTH.

The number of requests for information regarding the control of insects affecting live stock is greatly increasing, particularly from the prairie provinces. The red-tailed bot fly, *Gastrophilus haemorrhoidalis*, and the nose fly, *G. nasalis*, are becoming more abundant in the west. The warble flies, *Hypoderma bovis* and *H. lineatum*, are also becoming more widely spread and extending into new areas by the introduction of cattle from infested areas. Arrangements are being made for a study of the control of the warble fly in Quebec on co-operative lines.

We have now an extensive correspondence on the control of insects affecting the household. An endeavour is being made to substitute for fumigation with hydrocyanic acid gas the superheating method of eradication for bed bugs, as we have demonstrated the value of the latter method where it can be carried out. Its greater safety and cheapness are distinct advantages.

As time permitted, attention was devoted to a study of Canadian ticks and mosquitoes and a catalogue of the known species of ticks and their hosts was published during the year.

THE NATIONAL COLLECTION OF INSECTS.

Substantial progress has been made in the arrangement of the orders of insects in the National Collection and through the activities of the officers of the Branch a large amount of material is now being added annually to the collections. The collections are kept in the offices of the Branch and in the National Museum. New steel cabinets have been purchased for the housing of the collection in the Museum, but owing to the congestion of space in the latter building, due to its use as a House of Parliament until the new parliament buildings are erected, it has been considered advisable not to transfer the collections to their permanent home for the present.

The officers of the Branch are called upon to devote not an inconsiderable amount of time to the naming of collections submitted for identification. During the winter Dr. J. M. Aldrich, the leading authority on North American Diptera, visited us for the purpose of assisting in the naming of our collection of this order and he has laid us under a debt of gratitude for his help. We have also continued to enjoy the assistance which Dr. L. O. Howard, Chief of the Bureau of Entomology of the United States Department of Agriculture, so willingly renders and to him and his assistants in the Bureau and the United States National Museum our thanks are due for much valuable help in the determination of material.

MISCELLANEOUS.

PROTECTION OF BIRDS AND MAMMALS.

A large portion of my time is now being taken up by work in connection with matters of a zoological character. The most important work during the year has been in connection with the international convention for the protection of migratory birds in the United States and Canada. With a view to securing a settlement of outstanding objections to certain of the provisions of the convention I visited Washington recently.

During the year I have advised the Commission of Conservation on the protection of birds and mammals and my assistance along similar lines has also been sought by the Parks Branch of the Department of the Interior. Several lectures on bird protection have been given and the increase in correspondence on this subject is an indication of the added interest that is being taken in it everywhere.

As usual we have had many enquiries, especially from the prairie provinces for information on the destruction of noxious animals, particularly gophers.

CORRESPONDENCE.

The increase in correspondence continues in spite of the fact that, as a result of the permanent establishment of field laboratories, a large number of inquiries are now addressed direct to the officers in charge. The number of letters exclusive of circulars, etc., received from April 1, 1915 to March 31, 1916, was 7,127, and the number of letters sent out was 7,643, compared with 6,888 received and 8,107 sent out during the preceding fiscal year.

TRAVELLING.

During the year I visited all the field laboratories and fumigation and inspection stations and inspected the various lines of work now being undertaken by my officers in the different provinces. During Christmas week I attended the meetings of the American Association for the Advancement of Science, the Association of Economic Entomologists and the Entomological Society of America, which were held at Columbus, Ohio. I had the honour of being asked to deliver the annual address before the Entomological Society of America at this meeting, and also of being elected President of the American Association of Economic Entomologists for 1916. After the meetings a few days were spent at the Bureau of Entomology and the Biological Survey of the United States Department of Agriculture in Washington. A second visit was paid to Washington early in the present month.

PUBLICATIONS.

During the year the officers of the Branch, both at headquarters and in the field have contributed scientific papers to entomological and other journals, embodying results of too technical a character for publication in bulletin form. More popular articles on the prevention and control of insect pests, and warning notices have been contributed from time to time to agricultural journals and other papers.

The following bulletins and circulars have been published during the year; others are now in the press:—

BULLETINS.

Cutworms and their Control. By Arthur Gibson, Entomological Bulletin No. 10. 31 pp., 20 figs. 1915.

The Hessian Fly and the Western Wheat-Stem Sawfly in Manitoba, Saskatchewan and Alberta. By Norman Criddle. Entomological Bulletin No. 11. 23 pp., 4 figs. 1915.

CIRCULARS.

The Control of Locusts in Eastern Canada. By Arthur Gibson. Entomological Circular No. 5. 8 pp., 6 figs. 1915.

The Control of Cutworms in the Prairie Provinces. By E. H. Strickland. Entomological Circular No. 6. 8 pp., 5 figs. 1916.

The Results from Spraying in Nova Scotia. By G. E. Sanders. Entomological Circular No. 7. 11 pp. One spray calendar 1916.

The Suppression of Two Insects Affecting Troops. By C. Gordon Hewitt. Special Circular for the Canadian Expeditionary Forces. 6 pp., 2 figs. 1916.

The following articles also have been published in the Agricultural Gazette of Canada:—

The Control of Cutworms. By Arthur Gibson. Agricultural Gazette, Vol. 2, No. 4, pp. 330-332, 3 figs. April 1915.

House-fly Control. By C. Gordon Hewitt. Agricultural Gazette, Vol. 2, No., pp. 418-421. May 1915.

The Outbreak of the Western Army Cutworm in Southern Alberta. By C. Gordon Hewitt. Agricultural Gazette, Vol. 2, No. 6, p. 521. June 1915.

Investigations in the Control of Vegetable Insects. By Arthur Gibson. Agricultural Gazette, Vol. 2, No. 7, pp. 637-638. July 1915.

Two Serious Fruit Pests New to Canada. By C. Gordon Hewitt. Agricultural Gazette, Vol. 2, No. 8, pp. 732-37; 4 figs. August 1915.

The Introduction and Establishment in Canada of the Natural Enemies of the Brown-tail and Gipsy Moths. By C. Gordon Hewitt. Agricultural Gazette, Vol. 3, No. 1, pp. 20-21. Jan. 1916.

Rearing the Parasites of the Brown-tail Moth in New England for Colonisation in Canada. By Leonard S. McLaine. Agricultural Gazette, Vol. 3, No. 1, pp. 22-25, 5 figs. January 1916.

The Introduction and Establishment in Canada of the Natural Enemies of the Brown-tail and Gipsy Moths. By J. D. Tothill. Agricultural Gazette, Vol. 3, No. 2, pp. 111-116, 1 map. February 1916.

Injurious Shade Tree Insects of the Canadian Prairies. By J. M. Swaine. Agricultural Gazette, Vol. 3, No. 3, pp. 215-220. 8 figs. March 1916.

STAFF.

The following appointment to the permanent staff of the Branch has been made during the past year:

Dr. A. E. Cameron, M. A., was appointed a Field Officer during the present winter. Dr. Cameron graduated in 1909 in the University of Aberdeen with the degree of Master of Arts. After studying zoology and taking the further degree of Bachelor of Science, in Aberdeen, he took up advanced entomological work under Prof. Maxwell Lefroy, Professor of Entomology in the Imperial College of Science, London, and continued his entomological research work as an Honorary Research Fellow in the University of Manchester in 1912, where he took the degree of Master of Science (M.Sc.) He was appointed by the English Board of Agriculture and Fisheries to a Government Scholarship and continued his investigations in England and in the United States. In 1914 he spent a year conducting practical entomological work and spraying experiments in the Agricultural Experiment Station of New Jersey, under Dr. Headlee, State Entomologist, and returned to England to take up university work in Manchester and the University College of South Wales. He has published a number of entomological memoirs in various scientific journals and received his doctorate in 1915. His thorough scientific and practical training will make him a valuable addition to the entomological staff of the Department.

Mr. J. R. Gareau resigned in January on his appointment as forester to the J. B. Snowball Lumber Co., of Chatham, N.B.

In closing this report, it is a very great pleasure to acknowledge the whole-hearted manner in which all the officers, both at head-quarters and in the field, have assisted me. No staff could work with greater enthusiasm, more loyal co-operation or a fuller appreciation of the importance of their work. My especial gratitude and indebtedness are due to my Chief Assistant Mr. Arthur Gibson, who has charge of the work during my absence, and in addition to being responsible for the work of the branch relating to insects affecting vegetable and field crops, garden and greenhouse, has relieved me of much of the routine work. Mr. J. M. Swaine has charge of forest insect investigations, and the greatly increased interest now evinced throughout the country in this important branch of forest protection is due, in no small measure, to his tireless enthusiasm for his subject. Mr. A. E. Kellett has proved himself an excellent artist and photographer and the results of his work have received much commendation. During the past year Mr. J. A. Letourneau has undertaken much of the clerical work connected with the administration of the Insects and Pests Regulations under the Destructive Insect and Pest Act, and in addition has been responsible for looking after the accounts of the Branch. All this work has been performed in a very satisfactory manner. The increasing clerical work has been efficiently carried out by Mr. M. J. Moloughney and Misses J. McInnes and M. Dunham.

In November last immediately after the annual meeting of the Entomological Society of Ontario, which was held at Ottawa under my presidency, a conference of all my assistants and field officers was held and the

entire work and organisation of the Branch was discussed. As we had reached what had been termed the formative stage in the development of the Branch the results of this discussion was of the greatest value to my officers and myself.

I. ADMINISTRATION OF THE DESTRUCTIVE INSECT AND PEST ACT.

AMENDMENTS TO REGULATIONS.

With a view to enabling the provincial Department of Agriculture of Nova Scotia to co-operate with us in the fumigation and inspection of foreign nursery stock, as a provincial inspection service had been organised, Insects and Pests Regulation I, under the Destructive Insect and Pest Act was amended by Order-in-Council on August 18, 1915, by the insertion of the following words after the eleventh line of this Regulation:

Truro, N.S., and Digby, N.S., for nursery stock destined to points in the province of Nova Scotia only; from March 15 to May 15, and from October 7 to December 7.

The provincial Department of Agriculture of Nova Scotia has established fumigation stations at Truro and Digby, where importations of foreign nursery stock that is subject to fumigation under the regulations of the Dominion Department of Agriculture are fumigated. This work is carried on under our general supervision as in the case of nursery stock imported into British Columbia.

INSPECTION AND FUMIGATION OF IMPORTED NURSERY STOCK.

The following tables show the amount of imported nursery stock inspected during the importation season 1914-15. The disorganisation of trade in the exporting countries and of shipping due to the war resulted in a very marked decrease in the importations from Europe, as will be seen by comparing this year's figures with those of last year.

TABLE showing Countries of Origin of Imported Nursery Stock, Season 1914-15.

Nature of Stock.	Holland.	France.	G. Britain.	U.S.A.	Belgium.	Italy.	Japan.
Greenhouse plants.....	16,249		498	2	41,382		
Ornamental trees and shrubs.....	390,990	369,184	83,191	9,483	2,220	12	7,200
Conifers and evergreens.....	4,114	82,706	6,729	12	110		
Small fruits.....	5,594	2,300	33,993	821			
Fruit trees.....	70		997	16			1,010
Seedlings and grafting stock.....	9,500	1,118,675	149,500				

DESTINATION of Imported Nursery Stock Inspected during the Season 1914-15.

	Prince Edward Island.	Nova Scotia.	New Brun- swick.	Quebec.	Ontario.	Mani- toba.	Saskat- chewan.	Alberta.	British Colum- bia.
Greenhouse plants.....	43	2,939	1,987	12,336	37,525	811	200	205	2,045
Ornamental trees and shrubs....	823	11,393	4,889	54,832	682,015	28,454	22,000	191	58,250
Conifers and evergreens.....	75	763	.....	1,159	91,374	100	200	.....	.....
Small fruits.....	.....	1,150	784	1,394	30,224	16	173	50	8,390
Fruit trees.....	262	126	51	65	579	.....	.....	.....	1,010
Seedlings and grafting stock.....	.....	16,800	6,000	63,600	1,141,275	.....	.....	.....	50,000
Totals.....	1,203	33,171	12,711	133,386	1,982,992	29,381	22,573	446	119,695

Total Seedlings and grafting stock.....	1,277,675
“ Ornamental shrubs and shade trees.....	862,847
“ Conifers and evergreens.....	93,671
“ Greenhouse stock.....	58,091
“ Small fruits.....	42,181
“ Fruit trees.....	2,063
Total of all inspected stock.....	2,336,558

The above figures refer only to nursery stock subject to inspection and not to stock fumigated which greatly exceeds the amount inspected.

FIELD WORK AGAINST THE BROWN-TAIL MOTH 1914-15.

The situation in regard to this insect is well in hand owing to the efficient scouting work for the winter webs carried on by Messrs. G. E. Sanders and L. S. McLaine in Nova Scotia and New Brunswick respectively. The following are the reports submitted to me by these officers covering the season 1914-15.

NEW BRUNSWICK.

Mr. L. S. McLaine, who has charge of the work in this province, reports to me as follows:

The campaign against the brown-tail moth in the province of New Brunswick for the season 1914-15 shows that this insect has not yet become established to any great extent in the province. During the winter of 1913-14, 28,119 winter webs of the brown-tail moth were found and the area of infestation extended over nearly three-quarters of the province. In 1914-15 only 239 nests were collected. During the latter

season the area of infestation was found to be greatly reduced in comparison with that of the previous year and with two exceptions the winter webs were widely scattered. At least two reasons may be given as the cause of this tremendous decrease in the number of webs and the size of the area infested. First, unfavourable meteorological conditions at the time of the brown-tail moth flight; second, the heavy mortality of the caterpillars in the hibernating webs, due to the severe cold the preceding winter.

As I pointed out in previous reports the extent and amount of brown-tail infestation in the province of New Brunswick varies directly according to the meteorological conditions at the time of the brown-tail moth flight.

The present area of infestation includes the southern portion of Carleton county, where one web was found (Wakefield Centre); York county south of the St. John river, with the exception of one point (Kingsley, where one nest was found; Sunbury county, south of the St. John river; Queens county a light and scattered infestation over practically the whole area; Kings county, a scattered infestation running as far east as Hampton. No nests were found in St. John county. The infestation in Charlotte county was scattered lightly over the entire district. In 1913-14 Madawaska, Victoria, Carleton, York, Sunbury, Queens, Charlotte, Kings, St. John, Northumberland and Kent, eleven of the fifteen counties of the province were infested and two others (Westmoreland and Albert) had to be scouted. This year only six counties, Carleton, York, Sunbury, Queens, Kings, and Charlotte were infested and in one of these (Carleton) only a single nest was found.

As in previous years, observations were made at various points in the province during the brown-tail moth flight. At that time very few moths were seen or captured, in comparison with the number observed the previous season. During the early fall preliminary surveys were made in the worst infested regions in 1913-14, especially along the state of Maine line. The results from all the surveys showed that there had been a decided decrease in the number of moths that had entered the province at the time of flight, as very few nests were seen. While it was noted that the nests were fewer than in the previous year, they were more widely scattered and it was decided to scout the entire area infested in 1913.

On information kindly furnished by Mr. D. M. Rogers of the United States Bureau of Entomology, in regard to the brown-tail moth flight in northern New Hampshire and Vermont, it was decided to make a preliminary survey through the Eastern Townships of Quebec. The writer was accompanied on this trip by Mr. C. E. Petch, Field Officer for the province of Quebec. The survey started on November 2, and lasted about ten days. During that time the following localities were visited: Contrecoeur, Barnston, Ayers Cliff, Magog, the eastern shore of lake Memphremagog to Oliver, Georgeville, Apple Grove, Griffin, Beebe Plain, Stanstead, Moss River, Compton, Waterville, Dixville, Stanhope, Stanstead Mills and Sherbrooke. During this entire trip no brown-tail nests were seen. The scouting was considerably handicapped by the very bad weather and the poor state of the roads.

The actual winter work, that is the cutting off and collecting of brown-tail winter webs was started on November 20. A total of seventeen



FIG. 1.—Entomological Laboratory, Annapolis Royal, N.S.



FIG. 2.—Entomological Laboratory, Fredericton, N.B.



FIG. 3.—Collecting gipsy moth caterpillars for Tachinid parasite (*Compsilura*).

FIG. 4.—Method of rearing gipsy moth caterpillars for *Compsilura*.

FIG. 5.—Puparia of *Compsilura* and remains of parasitised gipsy moth caterpillars; also gipsy moth pupae.

men were employed in collecting these webs and they remained at work until March 18, when the work was completed. The meteorological conditions throughout the entire winter were excellent for carrying on the survey. There was very little snow, the temperature did not go as low as the preceding winter and the cold waves were not as prolonged. Rainstorms were more numerous than in 1913-14 but snowstorms were not as prevalent. Snowstorms delay operations longer than rainstorms, especially if the snow remains on the trees for any length of time. It is impossible to see the webs when the trees are covered with snow.

The work progressed much faster than the preceding winter. This was partly due to the fact that nearly all the men employed were trained scouts, and had at least one season's experience; furthermore all started work at the same time and last but not least very few webs were found.

A new method of scouting the infested area was adopted, the territory being divided into four main sections. In each of these sections a crew consisting of a foreman and three scouts was located. The sections were made up as follows: section 1 (northern) Carleton, Victoria, Madawaska and York counties (York south of the St. John river); section 2 (northeastern) York (Nashwaak Valley), Northumberland, Kent, Sunbury and Queens counties (north of the St. John river); section 3 (central) Sunbury and Queens counties (south of St. John river) and Kings county (north of Kennebecasis river); section 4 (southern) Charlotte, St. John and Kings counties (south of the Kennebecasis river).

The northeastern part of York county was left until the last and was scouted by all crews. New maps showing only a single county were issued to the scouts.

The provincial Department of Agriculture issued a bulletin of sixteen pages entitled "The Brown-tail and Gipsy Moths," prepared by Mr. J. D. Tothill and myself with your authorization. This bulletin was for free distribution and was sent to all school teachers in the province and to all individuals interested in the work. Two lectures on the brown-tail moth illustrated with lantern slides were given by the writer at the agricultural schools in Woodstock and Sussex. Several talks on the same subject were also given to school children in the county districts.

On account of the difficulty of locating and removing webs from the high trees in cities and towns in the province, a special crew of three men was formed to take care of this work. These men were thoroughly trained scouts, keen observers and good climbers. The crew was equipped with climbing irons, life belts, ropes, tackle, a thirty foot pruning pole, etc. The following cities and towns were visited: Fredericton, St. Marys, Gibson, Marysville, St. Stephen, Milltown, St. Andrews, Carleton, Fairville and St. John.

The following list shows the number of winter webs found in the infested counties of the province in 1913-14 and 1914-15:—

County.	No. of webs in 1913-14.	No. of webs in 1914-15.
Charlotte	7,458	264
Queen's	542	11
Simsbury	2,977	9
Kings	65	7
York	8,867	7
Carlisle	9,176	1
St. John	8	
Victoria	262	
Northumberland.....	41	
Madawaska	3	
Kent	1	
	28,100	239

The 239 webs collected this past season were found on six different kinds of plants. In 1913-14, when 28,100 webs were found, nineteen different sorts of trees served as host plants. Notwithstanding the difference in the number of webs found in the past two seasons it is of interest to note that there is very little variation in the percentage of webs found on the more favoured plants. This is borne out by an examination of the following table:—

PERCENTAGE of New Webs found on Various Kinds of Plants.

	1913-14.	1914-15.
Apple	87.84	86.19
Choke-cherry	4.13	5.44
Thorn.....	3.55	4.18
Amelanchier.....	2.53	2.51
Cherry-Red	0.27	1.25
Pawn	0.86	0.41
Elm	0.64	0.00
Oak	0.66	
Maple	0.03	
Birch	0.024	
Rose	0.024	
Hornbeam	0.021	
Willow	0.021	
Cornus	0.017	
Bush	0.014	
Pear	0.014	
Poplar	0.006	
Hazel	0.003	
Raspberry	0.003	
Approximately	100.00	100.00

Apart from apple, the remaining webs were nearly all found on choke cherry, thorn, Amelanchier and red cherry. All of these plants grow profusely along the fences in the back pastures and thus form ideal breeding places for the brown-tail moth and other injurious insects. If the insect were confined to orchards alone the chances of its becoming a serious pest would be slight, provided vigilant artificial control methods were practised, but the danger lies in its breeding on thorns, cherries, bilberries, etc., in places difficult for the inspectors to find and known only to the farmer who owns the land. It is to be hoped that before long the farmer will realise the danger that lies at his own door and awaken to the fact that something must be done to start a vigorous campaign against these favourite haunts of the brown-tail moth.

NOVA SCOTIA.

Mr. G. E. Sanders, who has charge of the work in this province, reports to me as follows:—

The control of the brown-tail moth has up to the present time been almost wholly dependent on the scouting work of the ten inspectors. The counties of Shelburne, Yarmouth, Digby, Annapolis, Kings and Hants were found infested in the season 1914-15, winter webs being taken from 155 localities as compared with 257 localities the previous year. Of these infestations 29 were new, while 131 of the localities found infested in 1913-14 were found free in 1914-15. In all 18,164 webs were taken during the season of 1914-15, a decrease of 6,002 from the number taken the previous year. The district infested has remained to a great extent the same for the past four years, the west end of Annapolis county, from Round Hill to Bear River being most heavily infested, the numbers dwindling east and west from this district to Kentville on the east and Yarmouth on the west, beyond which only scattered webs were found.

The number of winter webs found on the various food plants remain about the same, as follows:—

Apple.....	15,524	Birch.....	3
Pear.....	839	Black cherry.....	2
Thorn.....	835	Poplar.....	2
Amelanchier (Shad bush).....	319	Willow.....	1
Plum.....	285	Mountain ash.....	1
Oak.....	233	Aescia.....	1
Sweet cherry.....	41	Maple (Sycamore).....	1
Elm.....	26	Bayberry.....	1
Quince.....	20	Spiraea.....	1
Maple (White).....	14		
Wild cherry.....	10	Total.....	18,164
Rose (Wild).....	5		

The only great changes are an increase in the number on shad bush and on quince, which indicate more thorough work on the part of the inspectors rather than any change in food habits.

In all, 85 webs were found which had been missed the previous year. Of these old webs 39 were found isolated with the progeny amounting 12908—2½

in all to 246 new webs clustered near. This gives an average increase of 6.3 new webs from each old web, counting only those that were found within twenty-five yards of the old web.

During the season records were kept of the percentage of webs blown loose by the wind in various localities, as well as those so loosened that they had dropped from the jar caused by cutting the twig, and also bits of web found from which the webs had already dropped. The object of these records was to locate the districts in which the winter drop was heaviest, so that such places might be inspected first the following season, as well as to get the effect of various gales of wind on the webs throughout the winter.

Experiments were conducted under orchard conditions to secure the actual percentage of webs that drop from the trees during the winter. In one orchard in Tupperville this was found to amount to 25 per cent. In another orchard with trees planted 35 by 35 feet, webs were placed on the ground in the fall midway between the trees. In the spring 11.44 per cent of the larvæ contained in these webs were found clustered under the tanglefoot bands placed about the trunks of the trees to catch them. These experiments showed the great importance of collecting as many brown-tail webs as early in the fall as possible, and also how infestations may be kept alive, even though every web may be taken from the trees, by those which drop previous to the collecting of the webs.

Control of the brown-tail moth by the last summer spray.—Experiments were conducted to determine the extent to which the freshly hatched brown-tail larvæ when feeding in August were poisoned by the arsenic remaining on the leaves from the last summer spray applied about July 1.

Where paste lead arsenate was used alone or where any lead arsenate was combined with lime and sulphur, no webs were formed by the young brown-tail larvæ, showing that the last regular summer spray is a very great factor in brown-tail moth control in the province.

Breeding of Parasites.—In addition to the colonizing of parasites with which Mr. Tothill deals, our efforts to increase the numbers of the parasite *Apanteles lacticolor* were continued in five of the most heavily infested localities, namely: Bear River, Annapolis, Mochelle, Round Hill and Bridgetown, in the large parasite rearing pens devised at this station and described in our last Annual Report (pp. 16-17).

Flight of Moths in 1915.—During the latter part of July, Mr. S. H. Payne was stationed at Yarmouth to observe any flight from New England in case a repetition of 1913 should occur. As in 1914 only a very few male moths, which were presumably of New England origin, were observed.

Spraying as a factor in brown-tail moth control.—The chief factor that has had an appreciable effect in controlling the brown-tail moth, besides the work of the ten inspectors in collecting the webs, has been the increased amount of spraying practised in some sections. In the interests of brown-tail moth control as well as in the interests of the fruit industry of the province we have instituted an active "more spraying" campaign in an endeavour to have every orchard worth the name, or in any way commercial, sprayed. This means studying the insects of the apple, the carrying on of experimental spraying with the selection of demonstration orchards, and a publicity organization to carry the results of our findings and observations to the people we wish to reach. In this work we have the

co-operation of the Provincial Entomologist, Prof. W. H. Brittain, who is investigating the sucking insects of the apple, leaving the biting insects to this laboratory.

Summary of brown-tail moth work.—On the whole the brown-tail moth situation may be regarded as satisfactory. The experience of this season's work with that of past years confirms the belief that the present system of collecting the webs which is being improved as time goes on and with such increase in the amount of spraying as we can obtain it, can be relied upon to control indefinitely the brown-tail moths breeding in the province, but we are always open to another large influx of moths from the New England States such as we had in 1913 which more than doubled the number of webs in the province.

II. INTRODUCTION OF PARASITES AND PREDACIOUS ENEMIES OF BROWN-TAIL AND GIPSY MOTHS.

Through the continued kind co-operation of Dr. L. O. Howard, Chief of the Bureau of Entomology of the United States Department of Agriculture and of his assistant Mr. A. F. Burgess, in charge of the gipsy and brown-tail moth work, we continued the work described in my previous annual report of collecting, breeding and colonizing the chief parasites of the brown-tail and gipsy moths and of the predacious European carabid beetle, *Calosoma sycophanta*. The importation of these parasites began in 1911 and has been continued since that year. We are extremely grateful for this assistance so willingly rendered and for the provision of accommodation for our officer, Mr. L. S. McLaine, who has charge of the collection and rearing of these natural enemies, and his assistants at the Gipsy Moth Parasite Laboratory, Melrose Highlands, Mass., during the summer of 1915.

COLLECTION AND REARING OF THE PARASITES.

The following is taken from Mr. McLaine's report on this work:—

As in previous years the work consisted of the following main operations:—

1. The raising of the hymenopterous parasite, *Apanteles lacteicolor* Vier., which hibernates within the brown-tail caterpillar in the winter web and the shipping of the parasites in the cocoon stage to Fredericton, N.B., for colonization in the various provinces.

2. The raising of the tachinid fly, *Compsilura concinnata* Meig., and the shipping of the parasites in the puparium stage to Fredericton, N.B., for colonization.

3. The collecting of the predacious beetle, *Calosoma sycophanta* L., in the adult stage at various points in the field and the forwarding of the same to Fredericton for colonization.

4. The continuation of a series of feeding experiments to determine if certain forest trees, common to the Maritime Provinces and Quebec are suitable as food plants for the brown-tail and gipsy moths.

On account of the poor results obtained in the *Apanteles* work during the summer of 1914, a conference was held at the Parasite Laboratory

at Christmas time. Plans were made at that time to specialize on *Apanteles* this season and although not as many cocoons were obtained as in 1913 the results were more or less satisfactory.

The weather conditions during the past summer were exceedingly poor for parasite work. Spring started early but the weather remained cool and was accompanied by a great deal of rain. Rain continued throughout the summer, there being hardly a day in June or July without a shower. A motorcycle was furnished for the use of this work, and it was especially useful in the making of field collections.

The total number of parasites and predators raised and collected at the Melrose Laboratory and forwarded to New Brunswick during the past three seasons is as follows:—

Apanteles lacteicolor.

Year.	No. of brown-tail webs used.	No. of cocoons obtained.
1913	6,500	47,000
1914.....	6,700	2,000
1915.....	7,700	18,500
	20,900	67,500

Compsilura concinnata.

Year.	No. gipsy caterpillars coll.	No. puparia obtained.
1913.....	50,000	6,000
1914.....	73,000	5,000
1915.....	23,000	4,000
	146,000	15,000

Meteorus versicolor.

Year.	No. of cocoons obtained.
1913	475

Calosoma sycophanta.

Year.	Adults collected.
1913	200
1914	1,800
1915	1,400
	3,400

Apanteles lacteicolor.

In order to offset the poor results obtained in 1914, which were partly due to heavy mortality of the caterpillars in the nest, the mortality being caused by the severity of the preceding winter, it was decided to make collections of webs for this work before the severe cold set in and also to make collections from as many localities as possible. Webs were collected from three different states and in localities where *Apanteles* was known to occur.

The State Forester of Massachusetts, Mr. F. W. Rane, who has charge of all the gipsy and brown-tail moth work within the State, kindly consented to have his local superintendents make collections of webs. About thirty-five hundred webs were collected through his office and the collections were made in the following towns: Berlin, Bolton, Clinton, Hudson, Northboro, Shrewsbury, Worcester, Wetboro, and West Boylston.

The State Entomologist of New Hampshire, Prof. W. C. O'Kane, also kindly assisted in this work, assigning one of his scout foremen to make collections of webs. Five thousand webs were collected in New Hampshire from the following towns: Weare, Wakefield and Wilton.

On January 7 and 8, I collected three thousand webs at Woolwich, Maine.

Thus a total of eleven thousand webs were on hand for this work. These were all sent to the laboratory at Melrose Highlands and later were placed in cold storage until spring.

Previous experience has shown that too many nests should not be removed from cold storage at one time. When the parasites begin to emerge from the caterpillars they all come out within a few days; if too many feeding trays are started the same day some of the parasites will escape before all the trays can be examined and picked over. To prevent the emergence of parasites all at one time, the *Apanteles* work was divided into four series, that is, a certain number of nests were removed from cold storage on four different dates. The first series started on May 6 and the others on May 14, May 25 and May 29. On May 6 one thousand webs were removed from cold storage and placed in eight trays. The wild cherry—the emerging caterpillars being fed on this plant—was then in full leaf. The first *Apanteles* cocoon from the first series of nests was noted in the trays on May 29. The picking over of the trays started on June 1. This work continued until July 8 when the last tray was cleaned up. Each tray was picked over three or four times according to the number of parasites present. The picking over was done in the open air; rubber gloves, rubber armlets and cheesecloth neckbands, which were scalded each time they were used, prevented a great many of the brown-tail moth hairs from entering the skin and only a small amount of “rash” resulted. The cool weather also helped to keep the “rash” down. As soon as the cocoons were removed from the trays they were placed in an ice chest to retard the development of the adults. When a sufficient number had accumulated to warrant the making of a shipment they were removed from the ice chest and placed in pill boxes, a thousand cocoons to a box. The latter were then placed in a mailing tube and forwarded by mail to Fredericton and were colonized from there to various localities in the field.

Recovery of Apanteles in Charlotte County, New Brunswick.—Winter webs to the number of 185 collected in Charlotte county, New Brunswick, during the winter were sent down to the laboratory placed in trays and the parasites reared. From these thirty-four *Apanteles* cocoons were obtained. *Apanteles lacteicolor* was colonized in Charlotte county in 1913. Only 204 nests were found in Charlotte county last winter and it seems that this parasite is apparently well established notwithstanding the scarcity of the host.

Compsilura concinnata.

On account of special emphasis being laid on the *Apanteles* work the collecting of gipsy caterpillars for parasitism by *Compsilura* was not started until late in the season, July 7. General collections were made at twelve different points and 23,130 caterpillars in the 4th, 5th and 6th stages were collected. From these 3,384 *Compsilura* puparia were obtained. In 1914, 72,319 gipsy caterpillars were collected from nineteen different points but only 3,399 *Compsilura* were obtained. Consequently the percentage of parasitism was raised from 4.7 per cent in 1914 to 15.07 per cent in 1915. There is little doubt that the collecting of 23,000 caterpillars this season required as much labour as the collecting of the 72,000 in 1914, as the collections were made in localities where the gipsy moth infestation was exceedingly light.

The trays were examined daily and the *Compsilura* puparia removed to an ice chest. Upon making a shipment these were placed in a wooden mailing box, packed in damp moss and forwarded to Fredericton.

Calosoma sycophanta.

We collected 1,449 adults of the predacious beetle *Calosoma sycophanta* in the field. Nearly half of these were collected at Ballardvale, Mass., in one afternoon by two men. It was a warm sunny day after a few days of rain and the beetles were feeding on the caterpillars in the trees. The surrounding country had been scouted and very few beetles were seen. Towards noon the men found a grove of oak saplings, about fifteen acres in extent. The first tree shaken brought down five beetles and the work was continued until the above number were collected. The beetles are well scattered over the inside area of the gipsy moth infestation but it is difficult to find them in large numbers in a suitable collecting ground. A total of 1,385 adults were shipped to Fredericton for colonization in the Maritime Provinces and Quebec. These were packed in boxes containing damp moss, in colonies of one hundred, fifty males and fifty females, as described and illustrated in last year's Annual Report.

FEEDING EXPERIMENTS.

It was decided to repeat the experiments started in 1914 to determine what forest trees found in the Maritime Provinces and Quebec were suitable as food plants for the brown-tail moth. One hundred first spring-stage caterpillars were placed in a tray containing choke cherry and gray birch

foliage to see if the caterpillars showed any preference for these two plants. The caterpillars fed freely at first on the foliage of both plants, but towards the latter part of the season seemed to prefer the cherry. Twenty-five of the caterpillars pupated and fifteen moths emerged, consequently there is little doubt that the combination of these two plants is suitable as food for the brown-tail caterpillar. This is significant on account of the amount of gray birch and cherry in the "burnt over" areas in New Brunswick.

One hundred first spring-stage caterpillars were also used in all of the following experiments: some of the caterpillars fed on speckled alder, *Alnus incana*; poplar, *P. grandidentata* and yellow birch, *Betula lutea*, reached the fourth stage but none pupated. None of the caterpillars fed on American beech, *Fagus grandifolia*, or sugar maple, *Acer saccharum*, entered the third stage. These two plants are evidently unfavourable as food.

COLONIZATION OF PARASITES AND PREDACIOUS BEETLES.

The parasites and predacious beetles, collected in the New England States as described in the foregoing report of Mr. McLaine, were received and distributed in colonies in New Brunswick, Nova Scotia and Quebec by Mr. J. D. Tothill, Field Officer in charge of this work at Fredericton, N.B. As I have already reported, emphasis was placed on securing the two species *Apanteles lacticolor* and *Calosoma sycophanta* which were therefore introduced during 1915 in large numbers.

Mr. Tothill has furnished me with the following report on the progress of this branch of the work:

Compsilura concinnata was first introduced into Canada in 1912 and a few strong colonies have since been liberated each year. No attempt at recovery has been made and the present status of the species in Canada is unknown. The species seems likely to be the most efficient parasite of the brown-tail in boreal conditions and a special effort will be made in 1916 to introduce this two-winged fly in large numbers.

Calosoma sycophanta was first introduced in 1912 but not in large quantities until 1914 and 1915. It is now well distributed in the vulnerable portions of New Brunswick and Quebec. It has been carried through the winter at Fredericton under natural conditions near the laboratory, and a living specimen was ploughed up this year near one of last year's colony sites. It is certain therefore, that the beetle can and does winter over successfully in New Brunswick. It is not expected that the species will become abundant unless the much dreaded gipsy moth finds its way into the province and increases the food supply.

Meteorus versicolor has not been properly colonized as only a single small colony has been liberated. The species is, however, spreading naturally so rapidly from Massachusetts that it is doubtful if artificial methods of distribution, even if practicable, would be of any considerable value.

Apanteles lacticolor was first introduced in 1913 and in large numbers in 1915. It has been recovered every year, showing that it is firmly

established and likely to be of considerable practical value in the campaign. Little could be gained by making further liberations of this species in Nova Scotia, New Brunswick or Quebec.

These species are all polyvores, that is to say they feed on more than one insect host, and consequently can increase and multiply in the absence of a heavy infestation of the two particular insects they are intended to destroy.

The accompanying table shows where the various colonies of natural enemies of the gipsy and brown-tail moths have been liberated; it also indicates the strength of the various colonies:

DISTRIBUTION OF PARASITES AND PREDATORS IN CANADA.

NUMBER of Individuals Liberated.

Species.	Locality.	1912.	1913.	1914.	1915.
<i>Compsilura concinnata</i>	Fredericton, N.B.....	1,238	1,238	1,500	.....
	St. Stephen, N.B.....	1,119	1,500		.....
	Nerepis, N B		1,500		.....
	Woodstock, N.B.....			1,500	.....
	Harvey, N B			2,000	.....
	Koswiek, N B				1,800
	Bear River, N S		1,500		
	Annapolis Royal, N S				1,500
<i>Calosoma sycophanta</i>	St. Stephen, N.B.....	42	100		.....
	Whitner Ridge, N B		100		.....
	St. George, N.B.....			100	.....
	Nerepis, N B			100	.....
	Fredericton, N.B.....			100	.....
	Marysville, N.B.....			100	.....
	St. Leonard, N.B.....			100	.....
	Perth, N B			100	.....
	Florenceville, N B			100	.....
	Woodstock, N B			100	.....
	Canterbury, N B			100	.....
	Lawn-see, N B			100	.....
	Harvey, N B			100	.....
	Scotch Ridge, N.B.....			100	.....
	Basswood Ridge, N.B.....			100	.....
	Bear River, N.S.....			100	.....
	Annapolis Royal, N.S.....			100	.....

DISTRIBUTION OF PARASITES AND PREDATORS IN CANADA—*Continued.*

NUMBER of Individuals Liberated.

Species.	Locality.	1912	1913	1914	1915
<i>Calasoma sycophanta</i>	St. Rose, Que.			100	
	Sherbrooke, Que			100	
	Revoirs Corner, Que.....				100
	East Hereford, Que.....				100
	Dixville, Que				100
	Coaticook, Que.....				100
	Beaver Meadow, Que.....				100
	North Troy, Que				100
	Mansonville, Que				100
	Stanstead, Que				100
	Apple Grove, Que.....				100
	Way's Mills, Que				100
	Digby, N. S				100
	Weymouth, N. S				100
	Meteghan, N.S.				100
	Yarmouth, N. S				100
<i>Meteorus versicolor</i> ..	Whittier Ridge, N.B		475		
<i>Apanteles lacticolor</i> .	Whittier Ridge, N.B		4,400		
	Basswood Ridge, N. B		7,000		
	St. Stephen, N.B.....		7,000		
	Nerepis, N.B		3,001		
	Woodstock, N.B.....		2,000		
	Pear River, N. S		7,000		
	Dixville, Que				2,000
	Coaticook, Que				2,000
	Beaver Meadow, Que				2,000
	Way's Mills, Que				2,000
	Rosborough, N.B				2,000
	Poquiock, N.B				2,000
	Kewick, N. B.				2,000
	Fredericton, N.B				2,000
	Lincoln, N. B				2,000

The outlook for the success of this campaign is encouraging. The gipsy moth has not yet reached Canada but some of its most effective natural enemies are now established and ready to do their share in its control should it cross the international boundary.

In the case of the brown-tail moth the outlook is even more encouraging as it now seems certain that a heavy parasitism will not be necessary for the maintenance of control in boreal conditions, and the Canadian forests are all in this boreal life zone. This is inferred from the fact that there are three outstanding factors operating in the control of this insect in Canada that are not operative to a like extent in Massachusetts which is in the transition life-zone. First, there is a heavy winter mortality of the hibernating larvæ; secondly, the number of eggs laid in boreal conditions is measurably smaller than that laid in transition conditions; and thirdly, the light infestations that occur in boreal parts of Canada are probably largely controlled by predators such as birds of the warbler family (Mniotiltidæ). This third factor is not proven but is inferred by analogy from conditions proven in the case of another insect *Hyphantria*. In the case of *Hyphantria* the host is now exceedingly scarce in New Brunswick (as is the brown-tail moth), and parasitism is chiefly non-operative; there is however a complete control being maintained by birds. Three years ago the conditions were reversed, the host was fairly abundant (as is the brown-tail in Massachusetts), birds played little or no part in maintaining control, and a complete control was maintained by insect parasites.

The winter scouting work carried on in New Brunswick and Nova Scotia is of the greatest importance in preventing the light infestations developing into heavy infestations and thus assists the coming into play of this third factor.

NATURAL CONTROL OF NATIVE INSECTS.

In addition to the introduction of useful insects from the United States and elsewhere, the work carried on at the Fredericton Laboratory, New Brunswick includes the study of the natural control of certain of our most common insects.

Mr. Tothill, who has charge of this work, has furnished me with the following statement which briefly sets forth our reasons for undertaking what we regard as constituting one of the most important of our investigations.

It is a common experience of agriculturists and lumbermen that crops and trees are completely or partially destroyed from time to time by periodical outbreaks of insects. Such experience is common the world over but is very much more marked in large than in small areas of land. In Canada, few years go by without an insect outbreak on some one or more of the several essential crops: the army worm, the grain aphid, locusts, the tent caterpillars and the spruce bud-moth are familiar examples. These outbreaks are often the cause of very serious financial or other losses to large groups of people.

Very little is understood of an exact nature concerning the underlying causes of these outbreaks. It is known in a general way that Nature's balance has somehow been disturbed. It is also known that some insects,

birds and rodents, harmless enough in their native lands, have become veritable scourges when introduced into other countries: in these cases it is assumed, and in some cases definitely known, that there are factors of control present in the native lands and absent in the new. But the insect outbreaks are largely those of indigenous species and concerning the causes of these outbreaks practically nothing is known. If any of these outbreaks could be prevented the public welfare would be improved.

Prevention can only come through an understanding of the causes of outbreaks. It is precisely this problem that is claiming the most attention in the research work of the Fredericton laboratory. In order to ascertain causes of outbreaks it seemed necessary at the outset to study the natural control of some one or more selected species over a term of years at the same place.

Three insects of the many possible were chosen, each a common insect with a wide distribution. The requirements were fulfilled in the case of the fall webworm, the forest tent caterpillar and the spruce bud moth. The problem has now been studied for four years and will not be completed for at least another three years. For these particular insects some very definite information concerning the causes of increase and decrease has already come to light. At the end of the three years it will probably be known definitely, whether or not it will be practicable to utilise this information for preventing outbreaks.

In addition to the intensive studies being made of the control of these three insects, shorter studies carried on for one season only are being made on the control of various insects as occasion permits. Such studies are invaluable in that factors of control often entirely unexpected are occasionally discovered.

This year a study was made by Mr. A. B. Baird of the control at Fredericton of the ugly-nest tortricid, *Tortrix cerasicorana*. The results he obtained are as valuable as they are interesting.

III. INSECTS AFFECTING CEREALS AND OTHER FIELD CROPS, GARDEN AND GREENHOUSE.

Mr. Arthur Gibson, Chief Assistant Entomologist, who has immediate charge of investigations on insects affecting field crops, garden and greenhouse, reports to me as follows on the work and observations for 1915.

LOCUSTS.

These insects were again enormously abundant in various regions in eastern Canada, particularly in the provinces of Ontario and Quebec. The lesser migratory locust, *Melanoplus atlantis* Riley, was the species responsible for the chief damage, but associated with it was the pellucid locust, *Camnula pellucida* Scudd. The young locusts began to appear in large numbers towards the end of May, but owing to dull, cool conditions did not become very active until the first and second weeks of June. The crops attacked in 1915 were chiefly oats, barley, timothy, buckwheat, clover, tobacco, potatoes and corn. In one instance near Ottawa about 6,000 celery plants were destroyed.

Early in 1915 our Circular No. 5 entitled "The Control of Locusts in Eastern Canada" was published and widely distributed, and many

farmers followed the advice there given and saved their fields from the ravages of the insects. In the province of Quebec particularly, the farmers in certain parishes organized under the guidance of the resident parish priests and, in accordance with our instructions, distributed poisoned bait over large areas. In the parish of St. Etienne de Grès 21,000 acres were treated; in the parish of Mont Carmel 7,400 acres; in the parish of Alma 1,938 acres; in the parish of Pointe du Lac 1,600 acres, and in the parish of St. Boniface de Shawinigan 1,409 acres, a total of 33,347 acres being treated. I visited the two first mentioned parishes in June and was extremely pleased with the success of the campaign which had been waged by the farmers under the direction of Fathers Trudel and Fusey. In the parish of St. Etienne de Grès it was estimated that 90 per cent of the locusts had been killed and in the parish of Mont Carmel 95 per cent. The mixture used so successfully on both of these parishes was the following: Bran, 20 lbs.; Paris green $1\frac{1}{2}$ lbs.; lemons 3; molasses 2 quarts; water about $2\frac{1}{2}$ to 3 gallons.

In June we arranged to conduct an extensive series of experiments with poisoned baits near Bowesville, Ont., where the two above mentioned species of locusts were present in millions. Twenty-three experiments in all were decided upon, each poisoned bait to treat an area of 5 acres. Bran, shorts, sawdust and horse manure were used as carriers for the poison. The four mixtures which killed the highest number of locusts are the following:

	Mixture.	Death counts per square yard, 10 made in each field four days after application.			Cost of single application per acre including labour.
		Highest.	Lowest.	Average.	
1	Bran, 20 lbs. Paris green, $\frac{1}{2}$ lb. Molasses, 2 quarts..... Lemons, 3 Water, $2\frac{1}{2}$ gallons	710	50	202.8	19 cents.
2	Same as No. 1 with 1 lb. of Paris green instead of $\frac{1}{2}$ lb...	918	63	406.6	21 $\frac{1}{2}$ cents.
3	Sawdust, 20 lbs. Paris green, $\frac{1}{2}$ lb..... Salt, $\frac{1}{2}$ lb Water, 3 gallons..	720	30	228.6	7 cents.
4	Bran, 20 lbs Paris green, $1\frac{1}{2}$ lb..... Molasses, 4 $\frac{1}{2}$ qts Water, 2 gallons..	1,200	210	514.2	27 cents.

The fields in which the above experiments were conducted were apparently about equally infested and the destruction of insects resulting from the spreading of the above mixtures was, indeed, very striking. Mixtures in which sawdust was used as a carrier are very promising. A fuller account of these experiments is being published in the *Forty-sixth Annual Report of the Entomological Society of Ontario, 1915.*

CUTWORMS.

Serious outbreaks of these insects occurred throughout Canada in 1915. The most destructive infestation was that which occurred in the provinces of Saskatchewan and Manitoba. Many inquiries and reports of damage, accompanied by specimens were received from numerous places in these provinces. The larvæ received proved, in nearly every instance, to be the red-backed cutworm, *Euxoa ochrogaster* Gn. Hundreds of acres of wheat and oats were destroyed, and in gardens vegetables were freely attacked. One farmer reported the re-seeding of 640 acres. In the vicinity of Wadena, Sask., it was estimated that 3,000 acres of crop were damaged, 1,750 acres of which were totally destroyed. In view of the extensive nature of the outbreak of this cutworm, Mr. Norman Criddle, Field Officer in charge of the Entomological Laboratory at Treesbank, Man., visited infested areas and a brief report of his investigation is given on page 59.

From southern Alberta reports of the presence of large numbers of cutworms were received. These outbreaks were studied and remedial measures devised by Mr. E. H. Strickland, Field Officer in charge of the Entomological Laboratory at Lethbridge, Alta. An account of this work appears on page 62. In the province of British Columbia outbreaks of cutworms appeared in many places, but no extensive infestation was reported.

In the eastern provinces of Ontario, Quebec and the Maritime Provinces, considerable injury was effected. In the provinces of Ontario and Quebec, the striped cutworm, *Euxoa tessellata* Harr., and the dark-sided cutworm, *Euxoa messoria* Harr., were very abundant. Young beets, carrots, onions, etc., and flowering garden plants were destroyed. Along the north shore of the St. Lawrence river in Berthier county, Que., where large areas of tobacco are grown, extensive injury took place, chiefly by *E. messoria*. In June I visited Lanoraie and Lavaltrie, Que., and observed farmers in these districts replacing large numbers of destroyed plants.

In the province of Ontario an extensive outbreak of the glassy cutworm, *Hadena devastatrix* Bracc., occurred, the crops reduced being wheat, oats, barley, timothy and corn. The most serious damage was in the fields which in the previous year had been in sod. At one place in Simcoe county, a twelve-acre field of oats was destroyed with the exception of a few patches here and there. Another correspondent in Lambton county reports that four acres of barley had been entirely ruined. The injury by this cutworm was effected in May and June.

In the Ottawa district outbreaks of surface feeding cutworms were quickly stopped by using the locust poisoned bait No. 2, mentioned on page 30.

ROOT MAGGOTS.

A study of the life-history and the control of the cabbage maggot, *Phorbia brassicae* Bouche, has been continued at Ottawa, Ont., and conjointly in British Columbia by Mr. R. C. Treherne, Field Officer in charge of the Entomological Laboratory at Agassiz, B.C. At Ottawa we again demonstrated under field conditions, the value of the one-ply tarred felt-paper disc, as a protection to cauliflowers and cabbages against the attack of this insect. In one field where discs had been placed around 1,600 plants, practically every plant was protected from attack, while immediately adjacent other plants not protected were destroyed to a marked extent. Control experiments were also continued with liquid and dry applications of insecticides, etc. In the yearly results obtained at Ottawa, especially since 1910 and at Agassiz, B.C., since 1913, we have acquired valuable information on the life-habits, control, etc., of the cabbage root maggot, as well as important data on the imported onion maggot, *Hylemyia antiqua* Mg., (*Phorbia ceparum* Mg.) and the seed-corn maggot, *Phorbia fusiceps* Zett. A bulletin, therefore, has been prepared which we hope will be available for farmers and market gardeners in the coming spring (1916).

Both the cabbage root maggot and the imported onion maggot have caused heavy losses in all the provinces during the past year. One grower at Ottawa reported the loss of 3,500 early cauliflowers. The seed-corn maggot was destructive locally, chiefly in the provinces of Ontario, Quebec and New Brunswick, the important injury being to beans. In the province of Quebec near Montreal turnips were attacked.

MISCELLANEOUS.

The Pea Weevil, *Bruchus pisorum* L. From Peterborough county in Ontario, a report was received of a notable increase in the numbers of this insect. In a few other districts the pea weevil was also complained of. Ontario grown peas infested with this beetle have been offered for sale in the prairie provinces and also in British Columbia. No living weevils, so far as we know, were detected in such seed.

The Ash-gray Blister Beetle, *Macrobasis unicolor* Kirby. In the provinces of Ontario and Quebec large numbers of this blister beetle were observed in districts where the lesser migratory locust was abundant. At Lanoraie, Que., in late June, I saw thousands of specimens in potato fields, the plants in which were being rapidly defoliated. Near Ottawa, Ont., the beetles were found in abundance in early July. Reports of similar injury to the foliage of potato were also received from other districts.

The Carrot Rust Fly, *Psylla rosae* Fab. This insect was again destructive to parsnips and carrots in the Maritime Provinces as well as in the provinces of Ontario and Quebec.

The Pea Aphis, *Macrosiphum pisi* Kalt. This aphid was reported specially from the province of Quebec. Serious infestation occurred in counties south of the St. Lawrence river, according to our records, chiefly in La Prairie, Verchères, and St. Hyacinthe. From Champlain county complaints of injury were also received. In the province of Ontario the pea aphid was also present in injurious numbers in several districts, but the outbreak here was not nearly so serious as that which occurred in 1914.

The Potato Aphis, *Macrosiphum solanifolii* Ashm. A few complaints of injury by this plant louse were received from the provinces of Ontario, Quebec and Prince Edward Island. One correspondent in Hastings county, Ont., reported that the variety "Irish Cobblers" was affected the worst.

White Grubs, (*Lachnosterna* spp.) As was anticipated, these destructive larvæ were very numerous during the year, complaints of damage being received chiefly from the province of Ontario, but damage was also recorded from the provinces of Quebec and Prince Edward Island. In Ontario wheat, corn, potato and strawberry were freely attacked, in some districts whole fields being destroyed. One grower in Halton county estimated that 30 per cent of his potato crop had been devastated. In Prince Edward Island much injury was affected in lawns.

The Grain Aphis, *Macrosiphum granarium* Kirby. In the latter half of August this insect appeared in countless numbers in the grain fields of Alberta, and a great number of inquiries were received regarding it. It was thought by the farmers that great damage would result to such crops as wheat, barley, rye and oats, which were freely infested. As has been the case in previous outbreaks the aphides were soon attacked by parasites and predacious insects, and little serious injury resulted from the outbreak. One correspondent living near Bassana, Alta., whose oats were infested to such an extent that the binders became wet and slippery, afterwards reported that the plants were practically uninjured, and that the resultant crop was 104 bushels to the acre.

Wireworms. The destructive work of these larvæ was reported from all the provinces. Many complaints, chiefly from the eastern provinces, referred to injury to potato tubers. In some districts in the province of Ontario wheat sown on newly broken land was completely destroyed.

The Red Turnip Beetle, *Entomocelis adonidis* Fab. This insect has again been troublesome in western Canada. The chief reports of injury were received from the province of Alberta, the crops affected being cabbages, beans, turnips and radishes; in gardens in the neighbourhood of Edmonton entire crops of these plants were destroyed. At Peace River Crossing, in Northern Alberta, in one field about one thousand cabbage plants were destroyed.

The Twelve-spotted Asparagus Beetle, *Crioceris 12-punctata* L. It is interesting to record the occurrence of this insect at Ottawa in 1915. The common asparagus beetle, *Crioceris asparagi* L. was first found in the Ottawa district in September, 1906, but it was not until 1915 that it was again observed attacking asparagus and in this latter year in company with the first-named species.

A NEW VEGETABLE PEST FROM NEWFOUNDLAND.*

Towards the end of July Mr. Albert J. Bayly the Acting Secretary of the Newfoundland Agricultural Board forwarded to the Branch leaves of cabbages which were infested by a small tortricid larva. Mr. Bayly informed us that the caterpillars were present in destructive numbers on some farms near St. John's, Nfd.; on one farm in fact, the whole of the first and much of the second plantings of cabbages being destroyed. The larva curls the leaves like other tortricid caterpillars. Moths were reared at Ottawa in August.

INSECTS AFFECTING GARDEN AND GREENHOUSE PLANTS.

As time permitted, investigations in garden and greenhouse insects have been continued both at Ottawa and other places in eastern Canada. In the Montreal and Ottawa districts many greenhouses have been visited and considerable information obtained regarding the various kinds of insects which are now present. Much material has been collected which will be of value for study and museum purposes.

The following are the chief insects whose depredations during 1915 are worthy of record:—

The Black Vine Weevil, *Otiorhynchus sulcatus* Fab. This insect which has occasionally been complained of as a greenhouse pest, has this winter (1915-16) been very destructive to the roots and bulbs of cyclamens in several of the Montreal greenhouses.

The Greenhouse Leaf Tyer, *Phlyctaenia rubigalis* Gn. In greenhouses in the provinces of Ontario and Quebec, this well-known insect has caused considerable damage to the foliage of such plants as cinerarias, chrysanthemums, marguerites, and snapdragons.

The Marguerite Leaf-miner, *Phytomyza chrysanthemi* Kowarz. In many of the Montreal greenhouses this insect has evidently become well established. In our recent inquiry in that district, the insect was found to be attacking chiefly chrysanthemums, marguerites and cinerarias.

The Chrysanthemum Midge, *Diarthronomyia hypogaea* H. Lw. An interesting occurrence of this insect was discovered in an Ottawa greenhouse. The chrysanthemum plants had recently been introduced from the United States, and specimens of the midge reared therefrom were identified by Dr. E. P. Felt.

Other greenhouse insects such as white fly, mealy bugs, aphides and thrips were frequently reported as being abundant and destructive.

Among the insects destructive in flower gardens during 1915 the following are of interest:—

The Black-snouted Rose Beetle, *Rhynchites bicolor* Fab. In Manitoba this insect was unusually abundant in some districts and caused much damage in rose gardens by destroying the unopened buds.

The Four-lined Leaf-bug, *Poecilocapsus lineatus* Fab. The leaves of asters, dahlias, etc., were readily attacked by this insect in eastern Canada.

*Since the above was written further study of the moths reared proved that the insect was a new species. It was therefore described in *The Canadian Entomologist*, November, 1916, as *Tortrix oleraceana* Gibson.

The Red-headed Flea Beetle, *Systema frontalis* Fab. This insect was complained of in the Ottawa district in August as destroying the foliage of asters and chrysanthemums.

Cutworms. In eastern Ontario the striped cutworm, *Euxoa tessellata* Harr, the dark-sided cutworm, *Euxoa messoria* Harr., and the red-backed cutworm, *Euxoa ochrogaster* Gn., were responsible for much loss in gardens where annual flowering plants had been set out.

IV. INSECTS AFFECTING FOREST AND SHADE TREES.

The following report of the work of the Branch on insects affecting forest and shade trees has been submitted by Mr. J. M. Swaine, Assistant Entomologist in charge of this work.

The work of the year has been along similar lines to those followed in the three preceding years. Mr. R. N. Chrystal, Field Officer, has spent the greater part of the season between the months of March and November in charge of our work in British Columbia. The study of extensive insect outbreaks in the forests of that province has occupied much of our time during the last three summers.

AN INVESTIGATION OF FOREST INSECT CONDITIONS IN NORTHERN ALBERTA.

Reports of dying spruce in the Lesser Slave lake region of northern Alberta had been received describing conditions that indicated an outbreak of bark-beetles. Accompanied by Mr. Chrystal, I made an investigation into the cause of this injury during the month of August. Through the co-operation of the Dominion Forestry Branch we were afforded every opportunity for our work in the Forest Reserve south of Lesser Slave lake and elsewhere in this region. Our studies were made chiefly north and south of the Lesser Slave lake and at Mitsue, Alta., and Smith, Alta.

INJURIES TO SPRUCE BY *Dendroctonus borealis*.

Small outbreaks of *Dendroctonus* beetles in white spruce were located and the habits of the beetles were as thoroughly studied as the time and season would permit.

Dendroctonus borealis Hopk. This was found to be the destructive species. It occurs in abundance in the lower part of the trunks of dying trees, slashings and in stumps of white spruce, and it readily attacks and kills perfectly healthy trees when the right conditions occur for its rapid increase in numbers. The species was found to be very widely distributed. During the summer we located it at many places in the Selkirks and Rockies and northern Alberta, and in many cases small outbreaks in living white or Engelmann's spruce were developing. In the Lesser Slave lake region such incipient outbreaks were found in several places about the lake, at Mitsue, Alberta, and near Smith, Alta. We had not time to visit the larger outbreak of which we had received reports. This is apparently located on the Athabasca river below Mirror Landing, Alta. The main object of our trip was attained, however, in the study

of the life-histories and habits of the destructive species in the smaller outbreaks already mentioned. The species concerned in the larger outbreak was obtained by me two years ago at Athabasca, Alta., in logs floated down from the limits, and it is the same species studied this summer about Lesser Slave lake. Reports were obtained at that time of other outbreaks on the river below Athabaska, Alta.

OTHER INJURIOUS BARK-BEETLES.

An undescribed species of *Dryocoetes* was discovered killing large balsam near Nine-mile point, Lesser Slave lake. It apparently attacks healthy trees. *Dendroctonus simplex* was abundant in larch at Mitsue, Alta., and Smith, Alta., but was not found attacking healthy trees. A large collection of injurious forest insects was made, especially from spruce, balsam and larch, including many species of bark-beetles, and much information was obtained upon the habits of the most important species.

A DESTRUCTIVE WOOD-BORER, *Monohammus* sp.

The most destructive wood-borer of the region is a species of *Monohammus* closely allied to *scutellatus*. The eggs are laid in slits in the bark of injured or dying spruce trees or logs, mostly during July. The larvæ feed first in the soft inner bark and penetrate the wood to a depth of four inches or more before the end of the first season. During the second season the grubs complete their tunnels, frequently passing entirely through an eighteen inch log, and cut pupal cells just beneath the bark before the beginning of winter; the adult beetles emerge from the trees through round holes cut through the remaining thin layer of wood and bark during the following July, about two years after the eggs were laid. Over two million feet of fine white spruce logs were piled in open sunlight on the north shore of the Lesser Slave lake. Several piles had been cut three winters before, and the remainder two winters before. The beetles had nearly all emerged from the oldest piles when we examined them in August and had left the injured logs absolutely riddled with their borings; in the piles cut two winters ago the grubs were working from four to five inches below the surface of the logs. The adult beetles are most active in the sunlight and probably only the outer few layers of logs and the ends of the logs on the sides of the piles exposed to the sunlight were badly attacked. These were, however, practically a total loss. Ambrosia-beetles were working deep within the piles as evidenced from their small heaps of white boring dust visible from the sides of the log piles. The boring grubs of *Monohammus* have already caused great injury and if the piles are left out of the water much greater loss will ensue. This loss could have been entirely prevented by floating the logs before the July following the cutting.

The considerable but limited amount of good white spruce timber available in the region watered by the upper Athabasca and Peace rivers will be of inestimable value to the settlers who before many years will undoubtedly fill up the fertile lands of the great Peace river country.

It is therefore desirable to protect this valuable timber from serious injury by the destructive bark-beetles and wood-borers, whenever practical control measures can be applied. We are able now to recommend inexpensive and effective methods of control applicable to limits that can be logged profitably. We should next obtain more definite information of bark-beetle outbreaks in the more accessible districts so that control measures may be applied to check such as threaten to assume serious proportions.

A rather extensive rust injury to spruce was observed near Mitsue, Alberta. The appearance of the injury from a distance resembled that caused by the spruce bud worm.

INVESTIGATIONS IN JASPER PARK, ALBERTA.

A short examination of forest insect conditions was made in Jasper Park, Alberta. A large collection of bark-beetles and other forest insects was obtained there and much valuable information for possible future control work. *Dendroctonus borealis* is very abundant in spruce slash from trail cuttings, and may possibly become troublesome. The necessity for the proper disposal of slash from all cuttings in the Parks is discussed elsewhere in this report. Large numbers of young lodgepole pines have been injured by a boring caterpillar which feeds in the inner bark and cambium causing large gum masses on the young trunks and branches. The insect is evidently a serious enemy to reproduction.

INVESTIGATIONS IN BRITISH COLUMBIA.

The trip was continued through Prince Rupert to Vancouver. It had been planned to investigate the cause of the reported extensive bark-beetle injury to Sitka spruce on the Queen Charlotte Islands, B.C., but the closing of the lumber camps on the Islands, the difficulty of transportation, and our indefinite knowledge of the location of the outbreaks made the trip appear unprofitable at the time.

The two most important problems investigated by us this summer on the British Columbia coast were the conditions in Stanley Park, Vancouver, and the borer injury to cedar, known commonly as the "cedar worm". Our work in Stanley Park is detailed in Mr. Chrystal's report which is submitted herewith. The control measures carried out last winter in Stanley Park by the Park Board of Vancouver, according to our recommendations, have successfully checked the serious outbreak of Sitka spruce bark-beetles in the large spruce of the Park. The other injurious insects responsible for so much injury to the Park in previous years caused very little damage last summer, and it is hoped that careful inspection and prompt application of suitable control measures will prevent any such serious injury in the future.

The following report on the present condition of Stanley Park was made to the Vancouver Board of Park Commissioners:—

*"A Preliminary Report on Insect Conditions in Stanley Park,
Vancouver, September, 1915.*

"The Hemlock Injury.—The outbreak of hemlock caterpillars is over for the present. In addition to the large number of hemlocks killed during the last four years by the defoliation of these caterpillars, a number have died during the present season from the effects of the defoliation, and probably a few others will not survive. These dead hemlocks comprise the majority of the dead trees in Stanley Park. In addition to being extremely unsightly these dead and dying trees form a breeding ground for injurious insects and fungi, which will surely have a harmful effect upon the remaining hemlocks if allowed to breed undisturbed. We would recommend most strongly that every effort be made to have these dead and dying hemlocks removed as speedily as possible; the trunks should be removed from the Park and could probably be disposed of as firewood; the stumps should be cut as low as possible, and the slash should be burned. If the areas thus denuded are successfully replanted to Douglas fir, and a similar policy followed in the future, the permanence of the forest cover will be assured. The removal of these dead hemlocks and their replacement by Douglas fir is now the most serious problem affecting the health of the trees in Stanley Park.

"The Spruce Injury.—The young spruce trees along the driveways have been largely killed or very seriously weakened by the spruce gall aphid and the green aphid of the spruce, as described in previous reports. The dead trees should be removed and burned. Those so badly injured as to be useless should be removed and burned during next May or before June 15th. This has reference only to the few small spruces along the driveways.

"In our report made to your Board last summer, reference was made to a serious outbreak of the Sitka spruce bark-beetle in the large spruce in the Park. The number of beetle-infested green spruce had risen from less than six the previous year when the attack was discovered to about twenty-seven. It was recommended that those infested trees, then beyond all help, be removed during the winter and the broods of beetles in the bark destroyed to prevent the spread of the outbreak. This recommendation was carried out last winter, and as a result we have only three or four freshly infested spruces in the Park this summer. These are probably due to two of last year's infested trees which were missed when the cutting was done. If this control work had not been carried out last winter we should have had probably over fifty freshly infested large spruces in the Park this season. The few now infested should be cut this winter, and the bark on the trunks removed and burned.

"In this connection it should be emphasized that dying and recently killed trees of any species invariably serve as breeding places for insects and fungi and are therefore, a menace to neighbouring trees of their species. If allowed to remain standing, the falling branches and bark from the upper parts of the trunk endanger those persons passing below. All dying trees should be removed and burned as soon as their beauty is gone, and provision should be made for their replacement with Douglas fir.

"The trees in the Park are mainly hemlock, Douglas fir, cedar and spruce. The fir is usually sound; the cedar is affected by fungi causing heart rot and dead tops, but its condition cannot be materially improved, and is not more unhealthy in Stanley Park than in most places along the coast; the spruce and hemlock are the two species seriously affected by destructive insects, and causing the present unhealthy appearance in the Park. The recommendation for their treatment is given above. The following general recommendation we believe embodies the only permanent solution of the problem of producing and maintaining a healthy condition of the tree growth in Stanley Park: It should be a definite policy to remove dying and dead trees as soon as their usefulness is gone and so to check the breeding of insects and fungi; to remove or burn all slash from any cutting operations and prevent entirely the accumulation of dying and dead wood from any cause, preferably by burning it between the months of October and May; to replant the areas, large and small, denuded by the removal of dead trees, with Douglas fir. The British Columbia Forest Branch has offered to supervise such cutting and replanting. The hemlock is not thrifty under the Park conditions and will probably gradually die off, and if it is systematically replaced by Douglas fir the Park will gradually assume a permanent healthy condition.

"Insect outbreaks in the hemlock and spruce similar to those which recently killed so many trees will undoubtedly recur at intervals; but we hope to be able to examine the Park carefully each season for indications of such troubles and to advise the Commission of the proper control measures."

THE DESTRUCTIVE WOOD-BORER IN CEDAR.

Our study of the "cedar borer" commenced late this season and was carried out at various infested limits along the lower coast. The borer is an elongate flat-headed grub, the larva of a beautiful golden-green beetle belonging to the genus *Tracheole*. The grubs excavate very long flat tunnels through the heart wood of standing and felled cedars. The injury extends throughout the trunk from near the base into the branches of the extreme top and usually occurs in "dead top" trees, although we have rarely found it in those with the foliage perfectly green throughout. Further and more extensive studies of this important pest are planned for the coming season; it is particularly desirable to determine the limits of the infested area. Although the same or a similar injury to cedar has long been known in Washington and Oregon the first reports of serious injury from this cause in British Columbia reached us late in the season of 1914.

BARK-BEETLE INJURIES.

The bark-beetle outbreaks in yellow pine and western white pine are still spreading in most of the districts kept under observation during the past summer. Our studies of the habits of the most injurious species are now fairly complete, but considerable further work is needed in delimiting the infested areas.

INVESTIGATIONS IN THE DOMINION PARKS AT FIELD, GLACIER AND BANFF.

Short examinations of forest insect conditions were made in the Dominion Parks at Glacier, B.C., Field, B.C., and Banff, Alta. At Glacier the northern *Dendroctonus*, *D. borealis*, was abundant in slash from trail and timber cuttings, and was found in a few instances spreading to green standing timber. *Dendroctonus monticolae* Hopk. was found killing white pine near the driveway below the tunnel camp. An undescribed species of *Dryocoetes* was killing mature balsam at several places. A large and valuable collection of bark-beetles and other important forest insects was made from conifers of the region.

In the Dominion Park at Field, B.C., *Dendroctonus borealis* is killing mature spruce at several places. The outbreaks are not large but are adjoining the driveways and a number of fine trees have been killed. If the injury spreads, the beauty of those parts of the driveways will be largely destroyed. Balsam was being killed here also by the *Dryocoetes* previously taken at Glacier, B.C. Here as at Glacier, *D. borealis* had evidently spread from the slash of recent trail and timber cuttings. This bark-beetle is normally abundant throughout all this region in dying and dead trees of white and Engelmann's spruce.

At Banff *D. borealis* is abundant in spruce slash and *D. murrayanae* breeds in lodgepole pine. A valuable collection of bark-beetles and other forest insects was obtained near Banff in co-operation with Mr. N. B. Sanson, Curator of the Banff Museum.

THE DISPOSAL OF SLASH.

Whenever an exceptional opportunity for rapid breeding occurs, such as abundant slash from cuttings or extensive wind-falls, there is always danger that the destructive bark-beetles will spread to nearby green timber. Many bark-beetles of lesser importance as well as destructive wood-borers always multiply in such neglected slash. For this reason alone all slash in the Parks should invariably be piled and burned. If the cutting is made in winter, the tops, culls and stumps will be entered by the beetles during the spring and early summer following, and if the slash is burned late in the summer or early in the fall it will serve as a trap to destroy large numbers of injurious insects. If the cutting is made in the summer the slash should be burned during the succeeding winter or before the first of June. The chief consideration is the destruction of such breeding material before the broods can emerge from it to spread to the surrounding timber. Stumps serve as choice breeding places and should be cut low and barked to the surface of the ground.

OTHER FOREST INSECTS.

The outbreaks of the spruce bud-worm, *Harmologa fumiferrana*, recently so severe in Quebec province have largely subsided. In at least one instance a considerable area of spruce has died, probably from bark-beetle attacks upon trees already weakened by the spruce bud-worm

injury. As a rule, the bud-worm injured spruce has completely recovered. The most serious injury has been to very young and to mature stands of balsam; many of these trees have died from the repeated defoliation.

The larch case bearer, *Coleophora laricella*, has seriously injured large areas of larch in Quebec and Nova Scotia.

The larch saw-fly, *Nematus erichsonii*, was reported from several places in northern Saskatchewan. It appears to be spreading steadily to the west and north.

Tent caterpillars were injurious in parts of British Columbia, western Alberta, and in Nova Scotia.

Studies and experiments for obtaining the most effective methods of controlling the larger wood-borers of our eastern forests under the varying conditions found in different sections of the country have been undertaken and should be completed in 1916.

Injury to stored wood products by powder post beetles has been reported several times during the year.

SHADE TREE INSECTS.

The prairie provinces suffered severely from several shade tree insects during the past summer. Canker worms were particularly abundant and injurious in Manitoba and Saskatchewan. Injury by the negundo plant louse, *Chaitophorus negundinis*, and the negundo twig borer, *Proteopteryx willingana*, were unusually severe and wide spread. Poplars and willows were more or less completely defoliated in many localities by the poplar leaf beetle, *Galerucella decora*, and other leaf feeding species such as *Lina scripta*, *L. interrupta* and *L. tremulae*.

Considerable attention was paid to the more serious shade tree pests of the eastern provinces. It is planned to continue and largely extend these studies during the summer of 1916.

The elm leaf miner, *Kaliosphinga ulmi* Sund., has been introduced into southern Ontario in the neighbourhood of Kingston.

Our collection of Canadian forest insects and their work has been very largely increased during the year, and much time has been devoted to needed taxonomic and biologic studies, particularly in the families Ipidae, Cerambycidae, and Buprestidae.

REPORT OF THE FOREST INSECT FIELD LABORATORY,
STANLEY PARK, VANCOUVER, B.C., FOR THE
SEASON APRIL TO OCTOBER 1915,
BY MR. R. N. CHRYSAL.

THE SITKA SPRUCE GALL APHIS, *Chermes cooleyi* Gillette.

Further studies of the life-history of this form on the Sitka spruce, were made during the spring and early summer. During the first days of April the stem-mothers, which had passed the previous winter located on the spruce twigs, between the crevices of the bark, with their setae deeply sunk into the tissue, were observed to have commenced their oviposition on the spruce. By the sixth of April some of the stem-mothers had laid a large number of eggs, 200 to 300 being counted in some cases. About the middle of April the eggs began to hatch, and the young lice, which are light brown in colour, were observed to be locating themselves at the bases of the sound spruce needles. The time of hatching of the eggs and the bursting of the buds co-incided. On April 24 the first fully formed galls were found, and by May 5 they had become numerous, although owing to the weakened condition of the lower foliage of the spruce, the number of galls was considerably reduced this season. The earliest record of galls opening this year was about the 20th of June; this was considerably earlier than the previous year, which may easily be accounted for by the earlier season. Observations were again made this year on the migration of the winged forms from the galls on spruce to the needles of the Douglas fir, *P. mucronata*. Nothing further, however, of any note being added to the previous years observations.

Experiments on Cause of Gall Formation.—Some experiments were carried out early in the season, having for their object the determination of the exact parts played in the formation of the galls by the stem-mothers and their broods respectively.

Four separate experiments were tried as follows:

(a) A number of spruce twigs upon which stem-mothers were located, were chosen, and the eggs removed. This experiment was intended to show whether or not the sucking of the stem-mothers alone would prove sufficient to cause deformation of the needles.

(b) In this experiment the stem-mothers were removed, and the eggs left. To show the effect of the sucking of the young lice.

(c) Both the stem-mothers and eggs were removed, the twigs being dipped in a spray solution to thoroughly cleanse them. To show what effect such activity as the stem-mothers had shown up to the time of the experiment would have upon the development of the young needles.

(d) Fresh twigs of spruce, absolutely free of infection, were taken and eggs transferred to them to show whether the young lice would locate upon an untouched twig, and whether the irritation caused by their sucking would be sufficient to cause galling of the twig.

In a few cases the larvae of syrphus flies were found feeding upon the lice in the gall chambers; this was not at all common, however.

THE CHERMES ON DOUGLAS FIR, *Chermes cooleyi* var. *coweni* Gillette.

During the summer of 1914 the winged migrants of *Chermes cooleyi* from the spruce galls were traced with certainty to the needles of the Douglas fir, where they laid eggs, the young locating on the needles almost immediately and remaining unchanged both in size and colour for the remainder of the summer, fall and following winter.

Some of the twigs with the Chermes located on them were marked in October of 1914, and on February 25, 1915, Mr. R. C. Treherne reported that these Chermes were showing signs of development. On March 3, 1915, the lice had already moulted once and the woolly covering on their bodies had increased in amount. The beginning of April showed oviposition beginning in the open, and the first eggs hatched on May 5, the young locating on the developing needles of the fir, which were in various stages of advancement at that time. This generation was found to be dimorphic, a certain proportion of the lice developing wings. These winged forms commenced to leave the fir during the first few days of June, and were found to be settling on the needles of the Sitka spruce. Material of this louse was sent to Professor Gillette, Fort Collins, Colorado, who identified it as *Chermes cooleyi* var. *coweni*.

No serious damage to the Douglas fir in Stanley Park has so far been observed as the result of the presence of this louse. It is however, of direct importance to the spruce, as it forms the source of supply for new individuals to settle on the Sitka spruce.

THE SITKA SPRUCE GREEN APHIS, *Aphis abietina* Walker.

This aphis was present in very large numbers on the spruces in many parts of Stanley Park. Early in March Mr. R. C. Treherne, Field Officer, reported that the apterous females had begun reproduction, and that the yellowing of the affected needles was very marked. By the 9th of April the first winged forms left the spruce and they continued to migrate until well on towards the end of May.

Every effort was made to trace this form to its secondary host plant. A list was made of all the common plants growing in the vicinity of the affected spruces and specimens of these were planted in an area enclosed under a cheesecloth cage, into which winged forms were introduced. This was supplemented by field observations, on the foliage and roots of grasses, trees and shrubs of all kinds. These studies are not yet complete.

The damage done by this aphis affects the old needles of the spruce, which turn yellow and fall off the trees in May and June, giving the trees a characteristic appearance. The Sitka spruce in the Beacon Hill Park at Victoria has been very seriously attacked by it, several large trees being quite beyond hope of recovery.

Syrphus larvæ, spiders and coccinellid larvæ were found in considerable numbers destroying these aphides.

THE WESTERN HEMLOCK WOOLLY APHIS, *Chermes funitectis* Dreyfus.

Isolated hemlocks in Stanley Park were found to be badly attacked by this form, the woolly excretion of which caused the branches to look as if covered with snow. The stem-mothers began oviposition early in

April, the first young appearing about the middle of the month. The young, so far as was observed, migrate to the base of young hemlock needles, and there remain throughout the summer without much apparent change in growth. This species was found to be heavily attacked by syrphid and coccinellid larvæ. The species was identified by Professor Gillette of Fort Collins, Colorado.

The outbreak of the Sitka spruce bark-beetle, *Dendroctonus obesus* Lec., has been very effectively controlled by the measures for the destruction of the broods carried out last winter by the Board of Park Commissioners. Only three newly infested trees were found this season; they will be removed and burned this winter. F22

In addition to the work carried out in Stanley Park, trips were made to various parts of the province in connection with forest insect investigations. Studies were made at various places on the life-history and habits of a new species of *Platypus* which has been found doing great damage to logs of hemlock (*Tsuga*), balsam (*Abies*) and Douglas fir (*Pseudotsuga*) in the Coast region. The serious condition of the Sitka spruce in Beacon Hill Park, Victoria, as a result of the attacks of *Aphis abietina* has already been referred to.

Sechelt, Goat lake, and Stave lake were visited in connection with the reports of damage to western cedar, *Thuja plicata*, by the "cedar borer". Inquiries and observations made have resulted in the accumulation of considerable information concerning this borer, which was found to belong to the genus *Trachekele* of the family Buprestidæ. The damage is wrought in green timber, which renders the potentiality of this insect for destruction very much greater.

The month of August and part of September was spent on forest insect investigations in northern Alberta and northern British Columbia.

V. REPORTS OF FIELD LABORATORIES.

The following are summary reports of the work carried out at the Field Laboratories of the Branch.

ENTOMOLOGICAL LABORATORY AT ANNAPOLIS ROYAL, NOVA SCOTIA.

The main lines of work carried out during the past year have been the control of the brown-tail moth and investigations on the biting insects affecting fruit in Nova Scotia. A special study of insecticides and their comparative value has been commenced.

The description of the new laboratory erected during the past year and the report of the field work against the brown-tail moth have already been given (pp. 4 and 19).

On the other work carried on at this laboratory, Mr. G. E. Sanders who is in charge, reports as follows:—

INVESTIGATIONS ON ORCHARD INSECTS.

FRUIT WORMS OF APPLE.

During the season the life-histories of seven species of fruit-worms were studied in the laboratory by Mr. A. G. Dustan and the control of fruit-worms with arsenical poisons and methods of applying spray were studied in the field. The most important information gleaned from these experiments was the fact that the drive nozzle is very much superior to the old mist type of nozzles in fruit-worm control.

The efficiency of the two nozzles was compared in seven pairs of plots; in one pair of plots the percentage of apples showing fruit-worm injury was the same; in all of the other six the plots sprayed with the mist nozzles gave the most apples injured by fruit worms. More apples showed fruit-worm injury where the mist nozzle was used than where the drive nozzle was used. That these differences are caused by the mechanical effect of the drive nozzle is shown in the two plots which were sprayed with cold water only, and where the plots sprayed with the mist nozzle gave 77.7 per cent more fruit injured by fruit worm than the one in which the drive nozzle was used.

EXPERIMENTAL SPRAYING WORK.

During the season spraying experiments of various kinds were carried on in the orchards of S. B. Chute, Berwick; F. H. Johnson, Bridgetown; A. Fitz-Randolph, Bridgetown; R. G. Whitman, Round Hill and George Hoyt, Annapolis Royal. All of these owners assisted us in our work in every way possible and the practical interest shown by each of them

in the various phases of our work was most encouraging. We are indebted to some of them, particularly Messrs. Chute and Johnson, for many practical suggestions, which coming from time to time from these as well as other growers help in making our work of the utmost practical value. I wish here to express our gratitude to these gentlemen for their very valued co-operation and assistance.

BUD-MOTHS OF APPLE.

The life-histories of *Archips rosaceana* Harr. and *Olethreutes consanguinana* Wlsm. were followed through all stages, and descriptions were made by Mr. Dustan in the laboratory. Additional work was done on the eye-spotted bud-moth *Spilonota ocellana* Schiff, but owing to another species being mixed with it in the insectary all of its stages are not yet described.

During the season the lesser bud-moth *Recurvaria nanella* Hubn. was found for the first time in Nova Scotia. The last species is a native of Europe, but has been recorded from a large portion of the eastern half of the United States. In Benton Harbour, Michigan, it has been found by Scott and Payne infesting "more than 50 per cent of the fruit buds on the unsprayed trees," (p. 14 Bull. 113 U. S. Dept. of Agr.) so there is a possibility of this insect becoming a serious pest in the orchards of the province.

Further experiments in the control of the bud-moth were carried on in the field. Two important facts were learned. First, that two sprays before the blossoms, one when the leaf is the size of a ten cent piece, and the other immediately before the blossoms open, will kill more bud-moths than one spray three to five days before the blossoms open. Where the two sprays were used 75 per cent of the bud-moths that would otherwise have reached maturity were killed; where one spray was used only 51 per cent of the bud-moths were killed. Second, that the drive nozzle is superior to the mist nozzle in bud-moth control; in our experiment 92 per cent of the bud-moths that would otherwise have reached maturity were killed where the drive nozzle was used, while only 84 per cent were killed by the use of the mist nozzle. In seven experimental plots, where the drive and mist nozzles were compared, the mist gave more apples injured by bud-moth in every case.

CODLING MOTH.

The codling moth was conspicuous by its scarcity throughout the various experimental plots as well as in the orchards of the Annapolis Valley. The highest percentage of codling moth recorded for the season was in an unsprayed plot in Berwick where 1.7 per cent of the picked fruit was found to be infested. Apparently there is now such a high percentage of the orchards sprayed in the Annapolis Valley that those who spray are gradually controlling the codling moth for their neighbours who do not spray.

OTHER APPLE INSECTS.

The season of 1915 was marked by a large amount of injury by the fall cankerworm, *Alsophila pometaria* Harr. During November the adults were observed ascending the trees in greater or lesser numbers in practically

every orchard visited by the inspectors. Warnings in regard to it were issued in the papers in September, and a large quantity of tanglefoot was used by the orchardists as a result. Advice in regard to spraying for cankerworm in 1916 is now being published in the local papers and through other channels.

The eggs of the white-marked tussock moth, *Hemerocampa leucostigma*, are now becoming quite common in orchards, and are reported from practically every locality so far visited by the inspectors, showing that the province is on the eve of a widespread outbreak. Advice in regard to spraying for it next season is now being published. During the season the fall webworm, *Hyphantria textor*, was quite common in the west end of the Annapolis Valley, the larger webs attracting some attention, but the damage done by it was slight.

The tent caterpillars, *Malacosoma disstria* and *M. americana*, have decreased greatly from the season of 1914, only a very few cases of slight injury being reported.

TESTING OF NEW NOZZLES.

Tests of the Drive and Calyx nozzles which have recently come on the market were conducted. These nozzles are made for power outfits and require a pressure of 200 pounds to operate successfully. They both throw much more spray than the Mistry and Whirlpool nozzles against which they were tested, so only one of them is required to each rod. The drive nozzle as shown in the reports on bud-moth and fruit worm is much superior to any other tested in insect control. It throws a comparatively narrow spray with great force, and in this lies its greatest weakness as well as its strength, for in the hands of a careless operator, narrow strips or spaces will be missed in spraying and inferior control of fungous diseases result. However, in the hands of careful operators, the drive nozzle has proved superior to the mist nozzle in the control of fungous diseases.

The calyx nozzle throws a wider spray than the drive, breaks it up very finely and throws the spray with good force, considering the fineness of the particles of liquid. It has proved an excellent nozzle in the control of fungous diseases, and almost equal to the drive in insect control. For use throughout Nova Scotia, we are recommending the drive nozzle for the two sprays before the blossoms and the calyx nozzle for the sprays after the blossoms.

DEMONSTRATION ORCHARD.

A demonstration of the value of spraying was conducted in the orchard of George Hoyt of Le Quille. This orchard had never been sprayed before and in 1914 produced only fifteen barrels of marketable apples. This year it was sprayed four times and eighty-five barrels of marketable apples were packed. In September a meeting which was attended by about forty apple growers was held in the orchard. Counts of 2,000 apples from each of the three plots in the orchard showed .35, 1.4 and .25 per cent black spot on the Nonpareils.

SPRAYING CONDITIONS FOR 1915.

Throughout the spraying season there was an unusual amount of rainy weather, rain falling in greater or less quantities on twenty-one days during May, eighteen days during June and twelve days during July. As a result there was an unusual amount of black spot or apple scab. Many growers were unable to put as much spray as they desired on the trees on account of the rain.

A great amount of injury resulted from the use of lime sulphur solution at 1.008 sp. g., often as high as 40 to 50 per cent of the leaves being injured, and in a few cases definite reduction in the set of the fruit being traceable to the use of lime sulphur at that strength.

NEW SPRAYING MATERIALS.

In co-operation with the Provincial Entomologist, Prof. W. H. Brittain, a large series of preliminary experiments were conducted to determine the value of some of the new poisons now being placed on the market, and of new fungicides as carriers for the same. Altogether over 100 sprays and combinations were tested with very varied results. Some of the combinations show great promise, both in cheapness, handiness and freedom from certain caustic and wasteful qualities of the lime-sulphur, lead arsenate combination.

PUBLICITY WORK.

Owing to the value of spraying in helping to control the brown-tail moth as well as its extreme importance in the growing of good fruit in Nova Scotia, a vigorous campaign for more spraying has been carried on throughout the year. In all, thirty-one lectures have been given on insect control and spraying at various meetings including the Nova Scotia Fruit Growers' Association, the Annual Meeting of the United Fruit Companies, the Lawrencetown School Exhibition, the Annapolis County Farmers' Association and the remainder at various fruit growing centres under the auspices of the Nova Scotia Fruit Growers' Association and the County Farmers' Associations.

During the year twenty-nine articles, all directed towards increasing the amount and efficiency of spraying, have been written and published in the local papers, which are circulated through the fruit district. In October we were asked to take over one page of *The Co-operative News*, a fortnightly paper published by the United Fruit Companies and sent to each of their members—or 60 per cent of the fruit growers of Nova Scotia. Permission to contribute regularly to this paper has been granted by the Minister of Agriculture and we are now contributing timely articles on insect control, giving advance notices, where possible, of serious insect outbreaks, and soliciting articles from recognised authorities on various insects affecting the orchards of the province. In addition to this, we have had the personal canvass of our inspectors, who in covering the country on brown-tail moth inspection work are instructed to call when possible on every owner in whose orchard they find outbreaks of preventable insects and endeavour to get him to take steps to control the same.

I wish to express our hearty thanks to the representatives of the Dominion Fruit Branch, and of the United Fruit Companies for the support which they have given our work and my appreciation of the very efficient work of my assistants Messrs. A. G. Dustan and S. H. Payne, and the Dominion and Provincial Insects and Pests Inspectors, who have contributed greatly to making the work of the past year so successful.

ENTOMOLOGICAL LABORATORY AT FREDERICTON, NEW BRUNSWICK.

The work carried on during the year 1915-16 at this laboratory has included the following: the control of the brown-tail moth in New Brunswick and Quebec; the introduction and colonization of the parasites of predacious enemies of the gipsy and brown-tail moths; the study of the natural control of native insects and miscellaneous observations.

During the year a new laboratory was erected as already mentioned (p. 4) and it was occupied in the fall.

The results of the main lines of work mentioned above and carried on by Messrs. J. D. Tothill and L. S. McLane, the officers in charge of this laboratory, have already been described (see pp. 14-19). Mr. Tothill has been assisted by Messrs. A. B. Baird and Mr. F. M. McKenzie and Mr. McLane has had as assistants Messrs. W. N. Keenan and George P. Walker all of whom have rendered excellent service.

In addition to the reports already given, Mr. Tothill has reported as follows on the chief injurious insects in New Brunswick during the period 1912-1915:—

INJURIOUS INSECTS IN NEW BRUNSWICK, 1912-1915.

Spruce Bud-worm, *Harmolopa (Tortrix) fumiferana*.—Generally abundant and very evenly distributed over the entire province. A good deal of stripping occurred; there would have been more but for the unusual growth of *Abies balsamea* and *Picea canadensis* due to the extremely wet season. This is the third year of an outbreak and the insect is not quite as abundant as in the past two years.

Forest Tent Caterpillar, *Malacosoma disstria*.—For the past two years there has been much local stripping of *Populus grandidentata* and *P. tremuloides*. The local distribution in the province has been very irregular. This year it would have been even more abundant than it has been in the last two years. In June however, it was reduced to negligible quantities.

Apple Tent Caterpillar, *Malacosoma americana*.—This species was exceedingly scarce. In 1914 it was quite uncommon. In 1913 it was very abundant. In 1912 there was an outbreak ranging from Carlton, York and Charlotte counties through Maine and Massachusetts.

Fall Webworm, *Hyphantria textor*.—Exceedingly scarce in 1915. In 1912 it was quite common and it has decreased regularly ever since by about twenty fold each year.

Cutworms. Local outbreaks of cutworms caused considerable damage, particularly in the lower St. John river intervalles and in the neighbourhood of Sussex.

Colorado Potato Beetle, *Leptinotarsa decemlineata*.—Quite abundant generally in 1915 and has been so for four years.

Oyster-shell Scale, *Lepidosaphes ulmi*.—Abundant and has been so for the past four years.

Ctenucha Moth, *Ctenucha virginica*.—Uncommon in 1915. In 1914 uncommon. In 1913 an outbreak on grass lands at Harvey, Fredericton and other places in York county. In 1912 fairly abundant but no outbreak.

Larch Saw-fly, *Nematus erichsonii*.—Uncommon but not rare. In 1914 quite abundant. In 1913 an outbreak with stripping generally over the province. In 1912 as in 1913.

ENTOMOLOGICAL LABORATORY AT HEMMINGFORD, QUEBEC.

The following summary report of the work carried on at this laboratory during the season of 1915 has been furnished by Mr. C. E. Petch, the officer in charge:—

The season's work at this field laboratory which had been moved to Hemmingford from Covey Hill, at which place it was first established in 1912, commenced on April 15 and finished on November 15. The work comprised a study of the remedial sprays for apple curculio *Anthonomus quadrigibbus*, demonstration spraying, a further investigation into the use of *Coccobacillus acridiorum* for the control of grasshoppers and observations on other economic insects.

The weather was excellent for investigational work. The temperature on the whole was moderate with a medium amount of rainfall. Very hot periods existed during the first week of July and September and several orchards were injured by hail during these periods.

Material for the work in locust control was plentiful and also in some of the experiments against the apple curculio. Where there was a deficiency of insects the loss was largely made up for by the very necessary pioneer work in spraying.

SPRAYING EXPERIMENTS FOR THE CONTROL OF THE APPLE CURCULIO.

The extensive orchard experiments for the control of the apple curculio, *Anthonomus quadrigibbus*, and demonstration spraying were carried out in Huntingdon county under the direction of the Entomological Branch, Ottawa. This work was made possible through the co-operation of the Provincial Department of Agriculture in supplying a new "Friend" sprayer of the "King" model and the necessary chemicals for the work. The dormant spray had to be omitted because the machine was delayed in the delivery. Spraying commenced on May 5 and was carried on with the exception of rainy weather until June 18. There were 1,970 trees in the experimental orchards and they were sprayed three times as follows: 1. While the leaf buds were bursting; 2. While the fruit buds were bursting, and 3, shortly after the fruit had set. During the course of the work the fruit-growers were instructed how to mix and dilute the insecticides. Previous to the past summer these farmers, without exception, did not know how to spray a tree properly.

For the last application when the trees were in full foliage practically only two-thirds the quantity of material used in the first application, when the leaf-buds were just bursting, was required. This meant a saving

of 1,310 gallons of spray material. While the work was in progress the value of spraying was explained to the growers and they were shown the reasons for using different insecticides against different insects. The farmers were well pleased with the work because their fruit was never so free from pests as this year, except for the work of one insect—the apple maggot—which is to be investigated next year.

Among the worst pests for the past four years in this district were the tent caterpillars (*Malacosoma* spp.) but they were completely controlled during the past summer where the spray machine was used. Other things which impressed the farmers were the great saving of time and labour accompanied by an increase in the efficiency of the work. From observations in this district and after inspecting the results of spraying in other districts I am led to the conclusion that such demonstration work would be beneficial in most districts. This conclusion is supported by the amount of material it was found that the farmers used in the first and third sprays.

Besides dealing with orchard pests the farmers were given advice on the control of insects attacking their various farm crops. Such information is most beneficial because it allows the questions to be explained in detail.

RESULTS of Spraying for Apple Curculio.

Exp. No.	Treatment.	COUNT OF APPLES.		Percentage not injured
		Injured.	Not injured.	
1	Ars. Lead. Paste 4 lbs. to 40 gals. water.....	12	2,268	96.82
2	" " 3 " 40 "	Failure—no fruit.		
3	" " 2 " 40 "	Failure—no fruit.		
4	" Powder 2 lbs. to 40 gals. water.....	11	796	98.62
5	" " 1½ " 40 "	15	2,090	99.28
6	" Paste 3 lbs. to 40 gals. water..... and 1 qt. molasses.	14	834	98.30
7	" " 3 lbs. to 40 gals. Lime S.....	132	2,412	94.53
8	" Powder 1½ lb. to 40 gals. Lime S.....	112	6,056	98.13
9	" Paste 3 lbs. to 40 gals. Bordeaux.....	27	5,323	99.50
10	" Powder 1½ lb. to 40 gals. Bordeaux.....	9	683	98.68
11	Arsenite of lime 1 pt. to 40 gals. Bordeaux.....	1,013	7,858	87.11
12	Check plots combined.....	193	7,085	97.28

The infestation of varieties experimented upon was:—

	Per cent.		Per cent.
Thaler.....	28.05	Haas.....	1.58
St. Lawrence.....	19.16	Fameuse.....	1.55
Alexander.....	18.29	Jonathan.....	1.30
Ben Davis.....	3.43	Tetosky.....	0.91
Duchess.....	2.86	Brittle Sweet.....	0.45
Talman's Sweet.....	2.83	Winter Arabka.....	0.36

The results would appear to show that there is no choice between the paste and powdered forms of arsenate of lead as insecticides. Both adhered well to the foliage but the powdered form mixed far more readily.

INVESTIGATION OF CONTROL OF LOCUSTS BY *Coccobacillus acridiorum* d'Herelle.

The investigation of the use of this pathogenic bacterium was continued for a third season. This year the field trials were carried out at Lanoraie, Que., and commenced on June 30. The first inoculation was made from a culture diluted with distilled water. Two groups of thirteen series were inoculated and the organism was sufficiently virulent to cause death within five hours. Six pints of gelatine bouillon culture were inoculated from each of the two groups at 3 p.m. July 9, and were spread in the fields fourteen hours later. The inoculated field was in oats and the ditch alongside contained large numbers of grasshoppers. Even during the warm July nights the cultures solidified and it is probable that such a degree of temperature would seriously impair the development of the organism. The fact that d'Herelle's experiments were carried out in tropical regions would probably make a considerable difference. *Camnula pellucida* was the species of grasshopper chiefly inoculated for the following reasons; (a) same susceptibility to the organism as other species; (b) the body yields more readily to the hypodermic needle than most other species; (c) it yields more intestinal contents than most species.

The control of grasshoppers or locusts in eastern Canada by the use of *Coccobacillus acridiorum* d'Herelle so far has not proved to be possible, judging from the results of the experiments performed the last three years.

REMOVAL OF LABORATORY TO HEMMINGFORD, QUE.

Following recommendations made last year the laboratory was moved from Covey Hill to Hemmingford, Que., where it now occupies a prominent and convenient location, which will add materially to its value. Electric light has been installed which allows work to be done conveniently at night and aids materially in photographic work.

INJURIOUS INSECTS IN QUEBEC IN 1915.

Certain species of caterpillars were serious pests in the orchards but on the whole not nearly as bad as last year. The tent caterpillars, *Malacosoma disstria* and *M. americana*, which have done so much injury during the past four years were injurious again this year in a few orchards. The fruit tree leaf-roller, *Archips argyrospila*, was present but not in large numbers. At Lanoraie, Que., early in July the spiny elm tree caterpillar, *Vanessa antiopa*, was defoliating some branches. The bud-moth, *Spilonota ocellana*, did serious damage to apple buds at Covey Hill and Franklin Centre and in the latter part of August the larvæ were found seriously injuring the mature fruit of the Dutchess and Tetofsky. The oyster-shell scale, *Lepidosaphes ulmi*, was found quite plentifully on Dutchess apples late in August and to a lesser extent on other varieties later on.

The green aphid, *Aphis pomi*, was present in large numbers on apple buds at Covey Hill early in May and the woolly aphid, *Schizoneura lanigera*, was quite prevalent on elms at Lanoraie early in July. A click beetle was found attacking apple buds at Covey Hill and Franklin Centre during the time the buds were bursting. The apple maggot or railroad worm, *Rhagoletis pomonella*, was the worst fruit pest this past year and ruined several orchards by infesting about seventy-five per cent or more of the fruit. The most seriously injured varieties were Fameuse and Ben Davis.

Locusts were present in large numbers at Lanoraie, Valmont, St. Etienne des Grès and Lavaltrie and attacked principally oats and pastures. At Lanoraie, blister beetles were found in large numbers seriously infesting potatoes and they were accompanied in this work by large numbers of Colorado potato beetles. Cutworms were very prevalent in this district and did very serious damage to tobacco and garden crops.

ENTOMOLOGICAL LABORATORY AT VINELAND, ONT.

The following summary report on the work carried on at this laboratory has been submitted by Mr. W. A. Ross, the officer in charge, who was assisted by Mr. H. Curran. The main line of work has been an investigation of aphides attacking apple. In addition, observations have been made on the insects especially injurious in the Niagara district:—

INVESTIGATION ON APHIDES AFFECTING APPLE.

Apple Aphid.—The rosy aphid, *Aphis sorbi*, the green apple aphid, *A. pomi*, and the oat aphid, *A. avenæ*, were again abundant, and full advantage of this condition of affairs was taken to make a careful study of the three species both in the orchard and in the insectary. In the insectary the insects were reared from egg to egg on host plants grown in five inch flower pots.

The following is a summary of the results of my study on the life history of one of these species, namely, *Aphis sorbi*.

The eggs of the rosy aphid, *A. sorbi*, commence to hatch when the apple buds are swelling, usually about mid-April. The apterous parthenogenetic stem-mothers after passing through five instars, become sexually mature in about three weeks' time. Their progeny, i.e., the second generation, resemble them to a great extent in rate of development, in fecundity and in the absence of wings. During a period extending from mid-June to the latter part of July the third generation lice acquire wings and migrate to and establish colonies on *Plantago lanceolata*, *P. major* and *P. rugelii*. (It should be mentioned here that a small percentage of the migrants may belong to the second and fourth generations). On the secondary food plants the aphides breed rapidly and as many as eleven broods may arise. In the autumn alate sexuparae and alate males appear and fly back to the apple. The sexuparae give birth to young which in about five weeks' time become apterous oviparae. After being fertilized by the males the oviparae deposit their eggs on the twigs and branches.

The rosy aphid may be very destructive in bearing orchards. It not only curls and sometimes kills foliage, but by feeding on leaves adjacent to fruit it produces bunches of deformed and dwarfed apples.

In the following table comparative data on the development and fecundity of the different forms of *Aphis sorbi* are given:—

Form No.*	Moult	Age when Reproduction commenced.		Reproductive period.		Fecundity.		Daily Production.		Longevity.	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
		Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.
1.....	4	21	17	47	14	260	67	27	1	70	.....
2.....	4	22	17	39	10	206	44	17	1	71	.....
3.....	4	21	11	22	1	33	1	10	1	48	.....
4.....	4	14	9	33	1	116	2	11	1	53	.....
5.....	4	27	10	.....	.....	17	2	12	1	.....	.....
6.....	4	*35	21	.....	.....	.....	.....	.....	.....	45	30
7.....	4	45	30	22	1	6	1	1	1	65	41

*Became mature.

*No. 1 Stem Mother.

No. 2 Apterous vivipara, 2nd generation.

No. 3 Migrant to *Plantago*.

No. 4 Apterous vivipara on *Plantago*, 4th and 5th generations.

No. 5 Alate Sexupara.

No. 6 Alate male.

No. 7 Apterous ovipara.

INSECT ENEMIES OF APPLE APHIDES.

Several species of aphidivorous syrphidae were reared, and observations were made on other insects which attack aphides.

A list of the species which are of importance in the control of apple plant lice is given herewith: Coccinellidae:—*Adalia bipunctata*, *Coccinella novemnotata*, *C. trifasciata*, *C. transversoguttata*; Syrphidae—*Syrphus torvus*, *S. americanus*, *S. ribesii*, *Allograpta obliqua*, *Sphaerophoria cylindrica*; Oethophilidae—*Leucopis simplex*; Pemphredonidae—*Pemphredon inornatus* (preys on *Aphis sorbi* and other aphides); Chrysopidae—*Chrysopa plorabunda*.

PEAR PSYLLA, *Psylla pyricola*.

In a small infested pear orchard on the Vineland Experimental Station gratifying results in the control of this insect were obtained. In one experiment several trees were sprayed, after the cluster buds had burst, with lime sulphur wash, testing 1,030 specific gravity. In a second experiment with different trees, lime sulphur diluted to summer strength with tobacco water (1 lb. tobacco refuse in 2 gallons of water) was used and the application was made just after the blossoms had fallen. The results given by these two treatments can best be stated by quoting from notes made on May 22: "Exp. No. 1. Results good—very few nymphs are present on the trees. Exp. No. 2. Results practically 100 per cent effective—only one living nymph found. Check. Psyllas are numerous on unsprayed trees."

LESSER PEACH BORER, *Sesia pictipes*.

Early in the season many complaints were received from fruit growers regarding a "worm" which bored into the trunk and large branches of peach trees and produced gumming. On looking into this matter it was found that in practically all cases the gumming was primarily caused not by the "worm" but by the peach tree canker fungus. The "worm", the lesser peach borer, was however, very much in evidence in the cankered areas and by its work aggravated and greatly increased the wounds.

CHERRY APHIS, *Myzus cerasi*.

Last spring there was a serious outbreak of this plant louse on sweet cherries in different parts of the Niagara peninsula. In a Vineland orchard which I had under observation the young shoots were injured so severely that by the latter part of July most of the tender foliage was dead. The fruit in this same orchard was small, ripened irregularly and much of it was covered with honey dew and honey dew fungus. In fact so much damage was done to the fruit that most of the crop was left on the trees.

THE RASPBERRY BYTURUS, *Byturus unicolor*.

This insect is rarely troublesome in Ontario, however, during May it was present in a large raspberry plantation near Jordan in sufficiently large numbers to give a great deal of anxiety to the grower. The beetle destroyed many of the flower buds by eating into them. It also fed on and skeletonized the tender foliage, especially the leaves near the blossom buds. The owner of the attacked plants sprayed them with arsenate of lead and apparently got good results because when I visited his place later on I found comparatively few beetles on the bushes.

THE RASPBERRY SAW-FLY, *Monophadnoides rubi*.

This pest was very troublesome in 1914 but I regret to say it was much more destructive this past season. Two large raspberry plantations near Vineland were very badly infested and on many of the bushes all that was left of the foliage was the petioles and leaf ribs. The raspberry saw-fly is readily controlled by spraying with arsenate of lead, but as the insect is not regularly injurious the fruit grower seldom thinks of applying the remedy until it is too late.

ROSE MIDGE, *Dasyneura rhodophaga*.

This undesirable alien, which was first recorded by the Branch in Ontario in 1914, was again abundant in Mr. S. F. Wood's large rose garden near London, and by its nefarious work caused a serious loss of bloom on hybrid tea and hybrid perpetual tea roses. All the Polyantha, Bourbon, Hybrid China, Noisette and Winchuriana varieties in Mr. Wood's garden were exempt from infestation. The larva of this midge prevents blooming by feeding on and destroying the terminal shoots.

MISCELLANEOUS INSECTS.

The plant louse *Rhopalosiphum ligustri* was again very abundant on privet and as a result of its depredations several beautiful hedges were partially defoliated. The *Viburnum* aphid, *A. viburnicola*, was likewise abundant and injurious on *Viburnum opulus*. Scotch pines near the laboratory were rendered unsightly by a severe infestation of bark feeding woolly aphides, *Chermes pinicorticis*.

Complaints were received regarding the depredations of the following greenhouse pests: Sow bugs, white-fly, mealy bug and the scale insects, *Coccus hesperidum*, *Saissetia hemisphaerica*, *Aspidiotus hederæ* and *Hemichionaspis aspidistrae*. The efficacy of forcible sprinkling with water as a remedy for the greenhouse mealy bug was tested on a small scale and found highly satisfactory.

Asparagus beetle parasite, *Tetrastichus asparagi*. In asparagus fields at Vineland Station, Ont., the asparagus beetle which early in the season gave great promise of being unusually destructive, was satisfactorily held in check by a dark blue-green chalcid, *Tetrastichus asparagi*. A brief discussion of the life history and habits of this interesting parasite was published in *The Agricultural Gazette*, Vol. 2, No. 11 pp. 1055-1056.

ENTOMOLOGICAL LABORATORY AT STRATHROY, ONT.

The following summary report on the work carried on during 1915 at this laboratory has been submitted by Mr. J. R. Gareau, the officer in charge.

INVESTIGATIONS ON WHITE GRUBS, (*Lachnosterna* spp.).

The investigations on the species of *Lachnosterna* beetles occurring in the Strathroy district started by Mr. H. F. Hudson, in 1913, have been continued during the season of 1915, as well as the securing of information as to cultural methods or other means for their control.

LIFE-HISTORY STUDIES.

Collections of grubs from various localities were made, as for instance, from lowland where the degree of moisture is comparatively high; from highland where the soil is well drained; from bushland, etc. These grubs for convenience of study were placed in small tin salve boxes, one grub to each box. By such a method observations were made regularly on each individual grub, the facts recorded relating to feeding, moulting, etc. Unfortunately this year I was unable to begin any rearing work from the egg stage. The grubs collected were mostly one and two years old, although a number of 1915 grubs were also obtained.

At the end of the season the tin boxes containing the grubs were buried outside, at a depth of three feet to protect them from frost during the winter.

During the summer a certain percentage of the grubs died, apparently from varied causes. It is planned to investigate such matters further in order to determine to what extent these deaths are due to parasites, or to other causes.

INJURY TO CROPS BY WHITE GRUBS DURING 1915.

In the district of Strathroy corn and potatoes are grown largely by farmers, both of which crops white grubs are known to attack freely. In the district, too, are many hardwood trees which the adult beetles prefer as food.

During the early season of 1914 the adult beetles were abundant and as a consequence large numbers of grubs were present in 1915. Fortunately, however, the rain-fall was exceptionally high in the district during this latter season, and this undoubtedly is the reason why exceptional injury to crops, particularly those mentioned above, did not take place. Such weather conditions are unfavourable to the life of the grubs, while the crops, of course, develop satisfactorily, and injury which in other years might be serious is not so important owing to the plants being in a strong healthy condition and able to withstand the attack.

Early in the summer many fields were visited and in certain places corn was seen to have been destroyed. In such fields large numbers of grubs were found to be feeding on the roots and causing a stunted growth to the plants. In some areas in the Strathroy district there is no doubt that important damage was effected. At the time potatoes were being dug many farmers were visited and from counts made, an average of 5 per cent damage was noted. Pasture and hay lands were also noticeably infested by the grubs. In some fields conspicuous patches were seen to have been almost completely ruined.

OBSERVATIONS ON OTHER INSECTS.

Cutworms.—In gardens throughout the district these caterpillars were more or less troublesome, particularly to vegetable crops. Under field conditions corn and potatoes were injured to a slight extent.

Wireworms.—These insects were chiefly injurious to fall wheat. In some fields their depredations were sufficient to be quite noticeable.

Grasshoppers were very numerous but no complaints of important damage were received.

The Fall Webworm, *Hyphantria textor*, was found on wild cherry trees and also on apple trees but the caterpillars were not exceptionally abundant, and the injury, therefore, was not of much consequence.

The Black Walnut Caterpillar, *Datana integerrima*, was very abundant, being observed on almost every walnut tree. On some trees the caterpillars were present in numbers sufficient to destroy a considerable portion of the foliage. When trees growing on lawns were attacked spraying with a Paris green mixture prevented further damage.

ENTOMOLOGICAL LABORATORY AT TREESBANK, MAN.

The following summary report of the work carried on at this laboratory during the season 1915 has been submitted by Mr. Norman Criddle, the officer in charge:

Two special lines of research were undertaken during the year, one being the continuation of our investigations into the life-habits of white grubs, *Lachnosterna* spp., and the other, studies of the flies attacking cereals and grasses.

Serious outbreaks of cutworms occurred in both Manitoba and Saskatchewan which necessitated my devoting a good deal of attention to them, particularly in June. The season was also noteworthy on account of a very severe outbreak of plant lice which were found on almost every kind of tree, shrub and herbaceous plant. Several other pests of minor importance occurred during the season which will be dealt with below.

WHITE GRUBS, *Lachnosterna* spp.

Studies relating to the habits and life-histories of these insects were continued during the year and progress was made towards a better understanding of their modes of life. Numerous larvæ are now being wintered for the second time and it is expected that some important data will be available by the end of next summer. Apart from the rearing of white grubs in confinement, much attention has also been devoted to them in the field. Collecting behind the plough combined with digging in various unploughable localities has been the means of procuring many individuals, more than 700 of which have been placed in cages for further study and at least a hundred reared to maturity. As a result of this field work I am now able to locate the various species with considerable accuracy. It has been found as a general rule that one species does not invade the haunts of another and that while there is some over-lapping there are, nevertheless, localities where one species is found exclusively, in consequence of which it has been possible to check laboratory experiments with similar ones under absolutely natural conditions. This has of course, been a great help as it is only under natural conditions that the percentage of parasitism and of deaths from other causes can be ascertained. Field work has also revealed the fact that all our local species of white grubs burrow below the plough line in early October and that in some cases at least, the beetles do likewise, consequently late ploughing is of no value as a means of destroying them. Nor will early ploughing affect them owing to the fact that they seldom reach the surface before the first of May.

Parasites reared from white grubs during the year include three species of *Tachina* fly, one or more mites and a hair worm (*Gordeus* sp.) A fungus was also present and killed a number of grubs in September.

GRASS STEM-MAGGOTS. *Oscinidæ*.

The exceptionally favourable opportunity presented by the generous offer of Dr. J. M. Aldrich of the United States Bureau of Entomology to determine material, afforded us an opportunity of making a preliminary survey of these flies in Manitoba and of thus furnishing a basis upon which to work in the future. With this end in view sweepings were made as frequently as possible, of all the standard cereal and grass crops as well as from the commoner wild grasses. Two hundred sweeps of a net were made and the resulting catch placed in vials with the customary data. They were then mailed direct to Dr. Aldrich who sorted out the various species, determined them and returned complete lists as well as specimens of the various species. The information thus secured is exceedingly useful and should prove a great aid in determining the number and length of the various generations.

Some experiments were also made in breeding these flies and the following species were reared: *Meromyza americana* from growing wheat, rye, barley and several grasses. *Oscinis frit* from wheat, *O. coxendix* from wheat and corn and *O. dorsata* from corn. Another fly *Agromyza coquillettii* was reared as a miner in the leaves of wheat and barley.

CUTWORMS.

The study of these worms has been forced upon me, more or less, owing to their prevalence and the destruction they have done to crops. The species involved has in almost every case, been the red-backed cutworm, *Euxoa ochrogaster*, and the territory infested extended from Selkirk in Manitoba to Fort Pitte and Lloydminster on the western boundary of Saskatchewan. In view of the widespread infestation it was considered advisable to visit some of the more severely infested districts; in consequence a trip was made to Winnipeg during the middle of June and some of the worst infested farms were inspected. They were found to be very severely devastated. A trip was also undertaken along the main line of the Canadian Northern Railway as far as Warman, Saskatchewan, and a visit made to Margo in that province which was a centre of infestation. Rain and cold weather greatly interfered with my work throughout the entire trip and I was obliged, therefore, to confine myself to observations and advising farmers when to resow destroyed areas of crop, a lack of knowledge on this point having already been the source of considerable unnecessary loss.

Points of importance brought out on this trip may be summarised as follows: It was observed that certain areas formed what may be termed breeding centres and that from these the young grubs crawl to the surrounding lands. These breeding centres, which consist of the drier portions of infested fields are nearly always elevated situations consisting of ridges or low hills. But on land that is unusually level even elevations of a few feet will be selected for egg laying in preference to the surrounding portion of the field. In undulating country such as that at Margo, Sask., this preference for the hills was very marked. The hills in every instance being eaten bare and from them the larvae had crawled to the lower portions of the fields. A knowledge of these facts should, of course, prove of value to farmers in enabling them to watch these breeding areas for possible outbreaks and immediately taking steps to suppress them by means of poisoned baits, thus preventing a spread to other parts of the fields. Application of poisoned baits were made with much success by several of the market gardeners around Winnipeg, the usual mixture being: shorts 50 pounds, molasses 2 quarts, Paris green 1 pound and water 2 gallons. In most instances there seems to be a decided preference for shorts though excellent results have also been reported by the use of bran. There is no longer any reason to doubt the value of poisoned bait as a remedy for cutworms in gardens and it is only a matter of time before it will be universally used for that purpose in the prairie provinces. Something must yet be learned, however, regarding the comparative merits of the various ingredients recommended in its production thus necessitating further experiments along that line.

Several other species of cutworms were reared during the season and at least one (*Euxoa malis*) was added to the list of injurious kinds found within the province of Manitoba.

Some experiments were also carried on to ascertain the value of *light traps* as a method of collecting the moths and so controlling the number of eggs that would be deposited by them. The results of these experiments were even more conclusive than was anticipated from previous work along the same lines and strongly indicate that such methods are of little economic value in cutworm control. Two traps were used in this work, being placed to command areas known to be inhabited by cutworm moths. They were in operation on every favourable night throughout August and September. Yet during this entire period not a single specimen of the red-backed cutworm was secured, while of other harmful species taken a very large percentage were males. Another important fact is that the number of useful insects, including parasites actually exceeded in numbers the cutworm moths secured, hence we might conclude that traps actually did more harm than good.

A second trip was made to Winnipeg in September and on this occasion I attended the Kildonan fair and met many of the market gardeners of that district with whom were discussed cutworms and other insect pests.

It seems wise to insert a note of warning here regarding the handling of Paris green. Three instances of illness came to my notice during the year through inhaling the dust while mixing poison bait. It is well known that much mixing of Paris green usually causes sore lips and nose. All such accidents may be avoided by tying a handkerchief loosely over the mouth and nose while mixing it.

THE WESTERN WHEAT-STEM SAW-FLY, *Cephus occidentalis*.

Rather severe infestations appear to have occurred in parts of Saskatchewan, some fields being so badly attacked as to give the appearance of being hailed out. From samples of straw sent to the laboratory I judge that the insect is in a very healthy condition and is therefore apt to cause further loss next year. As is pointed out in our Bulletin No. 11, this insect always flies direct from last years stubble to the nearest growing grain, wheat or rye, and as it deposits its eggs upon the first plants met with, the edges of the fields are always more severely attacked than are the centres. As a result it is not necessary to plough the whole field. A strip varying in width according to the severity of the attack, should be ploughed deeply, where the damage occurred, and packed to prevent the flies making their way through in June. Ploughing should be done between August 1 and June 1 of the following year. Shallow ploughing is of no value.

A green aphid, determined by Mr. W. A. Ross as probably *Macrosiphum granarium*, became very abundant upon oats and less so upon wheat, barley and rye, during late July and early August. It was, however, severely attacked by Coccinellidae and hemipterous parasites and consequently did little injury.

INSECTS ATTACKING ROOTS AND VEGETABLES.

With the exception of cutworms, pests of gardens were less in evidence than usual. Some complaints were received of onion maggots from both Manitoba and Saskatchewan. Cabbage and allied plants suffered as usual, from the attack of the imported cabbage worm, *Pontia rapae*. An important event was the winter killing of Colorado potato beetles, *Leptinotarsa decemlineata*, over a large area of the province of Manitoba due to the absence of snow. In consequence potatoes were practically free from infestation in such places during the entire season.

INSECTS ATTACKING TREES AND SHRUBS.

Several leaf eating insects occurred in unusual numbers. The poplar leaf beetle, *Galerucella decora*, appeared in abundance over southern Manitoba and badly skeletonized willows and to a lesser extent poplars. Thousands have wintered in the vicinity of the attack.

The cottonwood leaf beetle, *Lina scripta*, spotted willow leaf beetle, *Lina lapponica*, and willow leaf slug, *Pteronus ventralis*, were all reported as causing injury to foliage in Saskatchewan. The larch saw-fly, *Nematus erichsonii*, again defoliated most of the larches in Manitoba, while the spruce saw-fly, *Lophyrus abietes*, occurred in numbers on white spruce and was particularly troublesome to ornamental spruces. A very unusual outbreak of plant lice took place during the season, commencing before the trees were in leaf and extending well into September. All kinds of trees were attacked as were also shrubs and herbaceous plants. The injury was particularly marked upon maples, *Acer negundo*, which suffered severely. As is usual in such outbreaks predacious and parasitic enemies become very numerous as the season advanced. In Winnipeg and some of the larger towns the two spotted lady-bird beetle, *Adalia bipunctata*, completely overcame the aphides on maples, while in the rural districts *Adalia frigida* was performing similar services. Several species of the genus *Coccinella* also became very abundant.

INSECTS INJURIOUS TO LIVE STOCK.

Blood-sucking flies were unusually scarce. Mosquitoes in southern Manitoba were practically absent owing to the lack of water for breeding places. The same cause probably reduced the numbers of tabanid flies. The stable fly, *Stomoxys calcitrans*, had increased at an alarming rate up to the winter of 1914-15 and during the summer of 1914 was a constant source of annoyance to cattle, horses and dogs. During 1915 however, there was a very marked change for the better, the flies being comparatively rare. Several causes for this decrease in numbers are possible, the most probable appearing to be the cold wet weather towards the end of June.

This report would be incomplete without mention of the enormous numbers of wasps present which became more and more abundant as the season advanced until the frosts of late September put an end to them.

Throughout August when the country was dry they swarmed in vast numbers to any available moisture and were a perfect pest to live stock at water troughs. The species involved appears to have been *Vespa vulgaris*.

ENTOMOLOGICAL LABORATORY AT LETHBRIDGE, ALTA.

The following summary report of the work carried on at this laboratory during the season 1915 has been submitted by Mr. E. H. Strickland, the officer in charge.

The season's work may be summarized as follows: The spring was marked by a serious outbreak of army cutworms. Prompt use of control measures and favourable weather conditions were effective in keeping the pest in check and comparatively little damage was recorded. Two records only of the presence of the common species of cutworms in grain fields were received. The damage ascribed to nematodes was not reported by fall wheat growers, and excellent crops were obtained on fields which were complete failures a few years ago.

CUTWORMS.

THE ARMY CUTWORM, *Chorizagrotis auxiliaris*.

This surface feeding cutworm which hitherto in Canada has not been considered as an important economic species, appeared in enormous numbers in the southern part of the province early in the spring. The species has been known as a pest, from time to time in Montana, where it is designated "the army cutworm", but on no occasion had it been as numerous as it was this year.

The eggs hatch in the fall, and the young larvæ appear above ground soon after the frost is out of the ground. They are entirely surface feeders, and are practically omnivorous, feeding upon all classes of crops, most weeds, prairie grasses and the bark of Manitoba maples. When food is scarce they assume the marching habit of army worms, and so spread from the weedy fields, where they originate, to clean land.

Control.—Broadcasting poisoned bait, although effective, is too expensive for prairie conditions, and is satisfactorily replaced by poisoning in specially prepared furrows. Dusty sided furrows, made by dragging a weighted log through a deep ploughed furrow proved to be best adapted to our soil and climate. A system of such furrows around a clean field when treated with poisoned bait kept the larvæ from gaining access to the field, and killed them in enormous numbers at comparatively little cost, while affected fields upon which the crop was not up were practically cleared of larvæ within a week by similar furrows, running east to west across them at intervals of twenty rods.

The two following poisoned baits gave the best results when applied to furrows:—

1. Shorts, 50 pounds; Paris green, 1 pound; molasses, 1 gallon; water, $1\frac{1}{2}$ gallons; applied at the rate of 10 pounds to 60 or 70 rods. This mixture, exclusive of labour, costs \$1.20 per mile.

2. Freshly pulled stinkweed, *T. arvensis*, or alfalfa, 50 pounds; Paris green 1 pound; applied at the rate of 10 pounds to 40 or 50 rods, and costing, exclusive of labour, 15 to 20 cents per mile.

The second bait is recommended wherever stinkweed occurs since it is a noxious weed and the benefit gained from pulling it pays for the labour that this involves. The freshly pulled plants are sprinkled with water and dusted with Paris green, which is then stirred well into them. The bait is as attractive as the best shorts mixture.

Poisoned larvæ remain in the furrows, and are eaten readily when dead by healthy specimens, and experiment showed that these dead larvæ act as an effective poisoning agent long after the bait originally applied to the furrow has been eaten.

A count of dead worms in a furrow, made one week after poisoning gave an average of 2,800,000 killed to the mile.

Parasites.—Of 167 larvæ kept in captivity, 28 per cent was parasitized. The most important parasite was a species of *Apanteles*, which was bred from 11 per cent of the larvæ. *Meteorus vulgaris* (8 per cent), *Copidosoma* sp. (6 per cent), a species of *Ichneumon* sp. (2 per cent) and tachinids (1 per cent) were bred also.

Diseases.—A bacterial disease, which turned immature larvæ pink, killed a high percentage of the larvæ at Welling, Alta. This disease could not be spread by artificial means tried, among which that of feeding healthy larvæ upon the body contents of dead specimens would have seemed to be the most certain.

A second disease found only in mature larvæ at Lethbridge, turned the body brown, and destroyed all internal organs.

Predators.—*Calosoma tepidum* and *Ammophila* sp. were unusually numerous in badly affected fields, and were seen to be doing good work.

Poultry and hogs destroyed many larvæ upon fields to which they had access.

Life-history.—Eggs have been obtained in captivity, though they were never found in the field. The larvæ from these eggs are being bred through to maturity in order that we may obtain details of development and variation.

Porosagrotis orthogonia.

This cutworm was seldom seen in 1915, and no reports of serious damage by it were received. Over twenty poisoning experiments conducted in modified Fiske trays, confirmed the statement made in 1914 to the effect that shorts is preferable to bran as a bait, and that sugar should be replaced by molasses. It was found, however, that when the soil is moist, harrowing in the bait is not so advantageous as it is when there is no moisture.

Eggs were again obtained from the soil but not from vegetation.

Euxoa ochrogaster.

Larvæ of this species were rare, except in gardens and no damage by them was recorded. Poisoning experiments gave similar data to those obtained from the *P. orthogonia* trays, but it was found that *Euxoa* is far more easily controlled than that species.

NEMATODES.

Little time was expended on the study of these animals in 1915, and no damage ascribed to them in fall wheat was seen or reported in any district. Infection experiments showed that *Aphelenchus* can gain admission to the tissues of healthy plants, though no recognisable damage resulted from the invasion. *Cephalobus* spp., which are the commonest soil nematodes, never entered healthy plants, while the comparatively rare species of *Tylenchus* were not recovered from infected plants. The large *Dorylaimus* species alone congregated among the roots, where they did no apparent damage.

GENERAL NOTES.

Several newspaper articles were written regarding army cutworms, as occasion demanded, and two circular letters were prepared for distribution in infected areas. Two addresses and a field demonstration upon control measures were given in the spring. A Riker mount exhibit showing insect pests of the district was prepared. This was shown at farmers' excursions to the Lethbridge Experimental Station, and at all the local fairs.

By the end of June the permanent new laboratory was completed and occupied. This greatly improves facilities for work.

The assistance rendered by Mr. F. M. Walsh has been of great value and has enabled more work to be undertaken than in the previous years. It also made possible a visit to the recently settled districts in Northern Alberta.

ENTOMOLOGICAL SURVEY IN NORTHERN ALBERTA.

The following is a brief summary of the entomological conditions seen in this region during a three weeks trip in August 1915:—

Athabaska Landing.—The country around this historic town is mainly timbered though it has suffered from frequent and extensive fires. Representatives of all orders of insects were remarkably scarce, and no records of pests to grain fields were obtained. In gardens, cutworms, apparently *E. ochrogaster* and wireworms are noticed from time to time though little damage is ascribed to them.

Peace River District and Grande Prairie.—This territory consists of stretches of rolling prairie alternating with woodland and is, for the greater part an ideal farming country. At the present time there are few insect pests and the complete separation of this country from all other farmed land should render the introduction of crop pests by natural spread almost impossible.

Among the native insects, blood-sucking flies are undoubtedly the most troublesome. In the hilly country around Peace River Landing where there is an abundance of running water, black flies, Simuliidæ, are extremely abundant. They do not attack man very readily but swarm upon horses, especially in the ears and between the fore legs. As a protection the horses' ears are covered with cloth when they are in harness, and pastures are provided with smudges. Larvæ were not found in streams examined and



FIG. 6.—Insectaries used in plant-lice investigations. Entomological Laboratory, Vineland Station, Ont.



FIG. 7.—Entomological Laboratory, Treesbank, Man.



FIG. 8.—Entomological Laboratory, Lethbridge, Alta.



FIG. 9.—Entomological Laboratory, Agassiz, B.C.

it is not known to what extent this fly breeds in the large rivers. Grand Prairie has little running water and no Simuliidae were seen there. Mosquitoes occur in varying abundance throughout the district and are extremely vicious in their attacks on man and animals.

Cutworms and wireworms were reported as injurious in the spring in most localities though in August no stage of either could be found. *Noctua claudestina* was taken at Beaverlodge but from our observations on this species we do not consider it to be the cutworm in question.

The red turnip beetle, *Entomoseelia adonidis*, is widely distributed and is reported to have been present in most districts when the first settlers arrived. It is probably indigenous to the country, but it is not often sufficiently injurious to warrant other treatment than hand picking.

A few accounts of cutworms or wireworms to grain crops were received, but no cases were seen. Wireworms seem to be confined to new land.

Grasshoppers constituted the only serious field pest observed. At Halcourt, in the Beaverlodge district, a field of oats had been attacked by two species of grasshoppers, determined by Mr. Norman Criddle as *Chorthippus curtipennis* and *Melanoplus bruneri*. These appear to breed in low-lying land at some distance from the field and to migrate in both nymphal and adult stages across the prairie, from which they gain access to the edges of the grain field. Farmers claim that their attacks can be averted by a few rods of fallow land between fields and the prairie bordering such breeding places, since the nymphs will not cross it.

Such outbreaks which appear to be common, though quite local, would be controlled without doubt by an application of a suitable poisoned bait around the edges of menaced fields.

No other grain pests occurred in injurious numbers though signs of thrip damage were seen on backward oats.

Grain aphides, *Macrosiphum graminum*, were abundant on grain crops during August, but had no appreciable effect on them.

Shade trees suffered somewhat heavily from aphid attacks but the latter were readily controlled by spraying with kerosene emulsion.

Myzus ribis was particularly abundant on currants, whereas *Aphis brassicae*, which was a serious pest of all cruciferous crops in 1914, was rarely encountered this year.

ENTOMOLOGICAL LABORATORY AT AGASSIZ, BRITISH COLUMBIA.

The following summary report of the work carried on at this laboratory, and review of entomological conditions in British Columbia during the period October, 1914 to October, 1915, has been submitted by Mr. R. C. Treherne, the officer in charge.

VEGETABLE AND FIELD CROP INSECTS.

The work with the cabbage root maggot, *Phorbia brassicae*, has been continued with the result that we are now able to advise the growers with much more satisfaction as to the life-history, habits and control measures than heretofore.

In a normal moderately dry season there are three complete broods. The conditions essential for optimum development are sunshine, a temperature approximating 70° F., with a reasonable amount of moisture. The appearance of the flies emerging from overwintering puparia in the spring varies in accordance with the climatic conditions. In a mild open month of March we should expect to find the first eggs deposited on available plants in the opening days of April. In a backward spring the oviposition of the first brood will not commence until May. Approximately forty-six days are required for the development of the first brood from the egg to the adult. According, therefore, to the climatic conditions in the early spring the question of egg deposition for the second brood varies. Supposing eggs were laid in a favourable spring on April 10, as we have observed, by allowing forty-six days for development, all eggs laid previous to May 25 would be eggs deposited by the first generation of flies and all eggs taken after May 25, may in addition to being delayed members of the foregoing, be eggs of the second generation or brood.

Further we have reason to state that practically the entire period of first generation oviposition is complete by the closing days of May in such a season as we are supposing and of which we have records to support. In other words, inasmuch as the winter is passed in the pupal condition, all these puparia will have passed into flies and these flies will have completed their oviposition by the closing days of May. This statement is obviously of great importance on account of its practical bearing on the issue at stake—the control of the fly. In the Lower Fraser Valley, to which these records pertain, in the ordinary season cabbage and cauliflower are raised in seed beds in the open ground. Hot-beds are not as a rule considered necessary. The time these beds are seeded varies in accordance with the season and transplanting follows about six weeks later. In 1915 transplanting took place on May 13, 1914, on May 26, 1913, on May 20, or approximating these dates. We have seen above that the oviposition period of the first generation practically ceases in the closing days of May or in other words conjointly with the period of transplanting. We are clearly of the opinion that one of the most useful remedies against the depredations of this fly is proper screening of the seed bed by means of strips of cheesecloth sewn together and laid over a wooden frame. Infestation of the seed bed is thus prevented.

Theoretically, if all cruciferous plants were screened during April and May our difficulties would cease. Practically, however, this is impossible. We can, nevertheless, do much to prevent the cabbages and cauliflowers, which will be transplanted just in time to receive the eggs of the second generation of flies, from being infested. It is recommended, therefore, that a seeding of radishes be made in the open, and that the radish plants be destroyed in three weeks after seeding. The radishes will act as trap crops, free to receive all the eggs the flies care to deposit. Inasmuch as the larval stage lasts approximately three weeks the radishes should be destroyed before the maggots can form puparia and pass into the ground. The labour involved in this method is not very great and provided the seed bed is screened and all old cabbages and other cruciferous plants be destroyed the measure will do much to save the season's plantation.

In support of these statements we have observed during the past season that between April 17 and May 31, 3,437 eggs were laid around 25 radishes, and average of 137.5 to the plant. All cabbages and cauliflowers were under screen at the time this observation was made, consequently the record on radishes is an average indication of the extent of the spring infestation. No attempt was made to destroy the radishes in the experiment, hence flies in due course emerged, forming the commencement of the second generation. Cabbages and cauliflowers were transplanted this summer May 13. The first infestation by oviposition in the plantation was noted on May 21, and from this day until the last day of September, on the record of 12 cabbages (May 21 to September 30) and 6 cauliflowers (June 25 to September 30), 11,137 eggs were laid, an average of 641 eggs to the plant. The seasonal prevalence of the fly under this condition of oviposition may be judged that out of 225 untreated plants only fifty died as a direct and proved result of maggot attack. One may with reason, therefore, say that the maggot was not seriously injurious under natural conditions during the past season. It has further been shown that these eggs, on the basis of over 2,000 were about 87 per cent fertile.

From these records, therefore, we claim that the screened seed bed and the growth and destruction of a trap-crop are two very important considerations for the commercial grower in the Fraser Valley. Many growers pursue the practice of seeding in the autumn and transplanting to the permanent plantation in the month of September. This is done for two main reasons, (1) to ensure earliness and (2) to establish the plant sufficiently to withstand the attack of the maggot in the spring. Indifferent success has attended the latter aspect. In a favourable spring the rapid development of the fly and the presence of few plants on which to oviposit, would afford a fall-planted cabbage little chance of survival. However, this fall-planting system, as many be imagined, partially interferes with the trap-crop scheme just outlined and further there is the possibility of infection from the plants of other growers to be considered.

Other methods of prevention and control were investigated and the past season's work, based on a study of nineteen different measures and insecticides, indicates that good results may follow the application of hellebore and pyrethrum in a solution of one or two ounces to the gallon, while felt-tarred paper discs and naphthalene moth-balls placed round the stem of the plants have also given good results. The use of felt tarred-paper discs in particular is recommended on large commercial areas of cabbages and cauliflowers.

Many facts of biological interest have been obtained from the study of this fly, but they will be dealt with in our bulletin on root maggots which is now being prepared.

Cutworms.—*Peridroma saucia* has been present again this summer in the Fraser Valley, not in marked numbers but sufficient to cause noticeable but localised damage.

The Cabbage Aphis. *A. brassicae* has been very common and destructive. More information is required on control measures.

The Cabbage Worm. *Pontia rapae* has been very common also and caused considerable damage. Dustings of pyrethrum insect powder

and cheap flour (one part of the former to four parts of the latter) is a most satisfactory remedy.

GRAIN INSECTS.

The Wheat Midge, *Diplosis tritici*, has again been the subject of investigation at Agassiz. Seedings on one hundredth part of an acre blocks were made on March 5 and 18; April 5, 14 and 24; May 3. Equal amounts of seed of the same variety were used on each block. The uniform basis of the experiment was interfered with by pheasants which picked up the wheat grains after seeding. In consequence the plan of bagging a number of heads every four days during the flowering period was resorted to. Later in the season examination was made for the degree of infestation in each respective bag. In this way we were able to tell with a moderate degree of accuracy the maximum oviposition period. It was shown that the early seeding on March 5 corresponded to the seeding on May 3 in the matter of infestation while the intermediate seedings were the worst infested.

Fall wheat showed no sign of infestation, hence while the midge remains a pest in the Valley, the seeding of fall wheat is recommended in preference to spring sown. Summarizing and deducting from the work of the past two seasons, if spring wheat is to be sown the earliest seedings possible in the spring are recommended. In general the conclusion is reached that there is little to be expected from a choice of the time for seeding in the spring on account of the fact that the maximum period of oviposition appears to coincide with the blossoming period of the best time to sow. Much importance, however, is attached to deep autumn ploughing and the proper disposal of the sweepings from the barn floor after threshing.

The Pea Weevil, *Bruchus pisorum*. Specimens of this insect were taken in seed peas supplied to growers in the Agassiz district by a Vancouver seed merchant; these peas had been imported from Ontario. All of the insects were dead but there is a possibility that live weevils have been introduced. It is to be hoped that proper precautions will be taken to maintain the present freedom of the province from this pest.

Aphides on grain, *Aphis avenae*, were more in evidence this year than heretofore, but a high degree of parasitism is recorded, which indicates that under normal conditions the insect is naturally controlled. The migration of the aphides and consequently the period of infestation for the grain occurs from the middle till the end of June and part of July in this locality. Winged forms were observed on wheat late in July and during August.

FRUIT INSECTS.

A practical orchard demonstration on the control of the apple bud moth, *Spilonota ocellana*, which was planned to put into practice the results of the investigations of the past two years unfortunately did not materialize. Pending information gathered from such an investigation, the grower is being advised to include arsenate of lead in his two spring 'scab' sprays both of which are essential sprays for the production of clean fruit in the Lower Fraser Valley.

The Lesser Apple Worm, *Enarmonia prunivora*, is becoming every year a more important apple pest. Two attempts in the past three years have been made to study its life history, but owing to lack of material little progress has been made.

The Currant Fruit Fly, *Epochra canadensis*, is another insect of increasing importance of which we have as yet made no attempt to investigate the life-history. Its presence is recorded from a great many sections of the province.

The Peach Twig Borer, *Anarsia lineatella*, also requires attention. It is becoming increasingly more important in the South Okanagan district notably around Summerland and Penticton.

The San José Scale, *Aspidiotus perniciosus*, is again reported in the province. An occasional record has been received of this scale from time to time in the years gone by. It is only within the past three years that it has attracted attention again. Presumably introduced on nursery stock from Ontario it became established at Spences Bridge. Vigorous measures were instituted against it by the Provincial Fruit Inspector with the result that the situation was well in hand by the close of the 1915 summer.

The Codling Moth, *Cydia pomonella*. The present condition of this insect in the province is causing considerable apprehension. Two important areas of infestation are recorded for this season, one at Westbank and the other at Okanagan Landing. Both these outbreaks are believed to be the most serious that have occurred as yet. Hitherto, owing to the comparative isolation of the fruit growing areas of the province from existing areas of infestation in the United States, and thanks to an efficient system of fruit inspection and orchard patrol which has been carried out by the Provincial Inspector of Fruit Pests the province has enjoyed a freedom from this pest. Now through the medium of infected packing cases and railroad freight cars, the moth on liberation is gradually finding conditions of existence more and more satisfactory owing, mainly to the fact that the number of young orchards being brought to bearing age is rapidly increasing. The truth is being gradually brought home that the province cannot much longer continue to enjoy the former freedom from this pest.

Many growers have been led to believe and still believe that individual effort is not required in the control of important orchard pests. According to your instructions, therefore, plans are being made to carry on an investigation to determine exactly the life-history and bionomics of the moth under our local conditions in British Columbia, with a view to assisting the growers when the burden of control falls on their shoulders.

The Strawberry Root Weevil, *Otiorhynchus ovatus*, has made its appearance and is establishing itself in certain areas to a marked degree, in the Gorden Head and Keatings districts near Victoria. We have little to add to the bulletin already published (Entomological Bull. No. 8) on this insect from the Entomological Branch, beyond stating that the dates of movements occur possibly a trifle earlier than on the Lower Mainland. In short it may be said that growers are advised to curtail the number of years they 'run' their plantations, thus not allowing the

weevil to become too strongly entrenched and further ploughing operations are better delayed until after August in infested spring plantations.

The Pear Thrips, *Taeniothrips pyri* Daniel. A serious infestation of this insect was discovered this spring (1915) in the Victoria district. All possible steps were taken to estimate the extent of the area involved and growers were advised about the serious condition liable to arise if proper steps are not taken to offset the outbreak. According to your instructions an attempt will be made to control the insect in the spring of 1916 in co-operation with the provincial authorities, and an investigation on the life-habits and bionomics will also be commenced.

The Currant Bud Mite, *Eriophyes ribis*. It is with regret that I have to record the presence of this mite from the Duncan district of Vancouver Island for this past spring (1915). The well known indications of the pest were mentioned to me at an Institute meeting at Duncan last April. On the receipt of currant twigs, by request, I had no difficulty in determining the pest. The determination was later supported by you on the receipt of specimens and it is to be hoped that time will allow a study of the mite, especially in its relation to native currants that occur in the woods.

In concluding this my seventh annual report I wish to place on record my special appreciation of the manner in which those Field Officers who applied for leave of absence to serve in the Canadian Overseas Forces and were not permitted to enlist have continued on their work, which at times was carried on under great difficulties. The importance of maintaining the agricultural production of the country has rendered it necessary to retain those whose special scientific qualifications render them more useful to the state in a civil than in a military capacity. Their work may have appeared to be less glorious, but it is not less important to the welfare of the country.

C. GORDON HEWITT,

Dominion Entomologist.

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